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THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD, B.W.I.

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TROPICAL AGRICULTURE is published monthly at the Imperial College of Tropical Agriculture, St. Augustine, Trinidad, West Indies. Advertisement and subscription rates can be obtained at the College from the Editor, or from the Secretary of the College, 14, Trinity Square, London, E.C. 3, England. The Editor will be glad to consider authoritative articles for publication. It is understood that opinions expressed or recommendations made in signed articles or in articles of which the source is named are those of the author and do not necessarily represent the policy or opinion of the College Authorities. Increasing numbers of inquiries are being received from various parts of the tropics which can be answered only by persons possessed of an intimate knowledge of local conditions. Enquirers should first satisfy themselves that their local Department of Agriculture is not able to supply them with the desired information before communicating with us. Correspondence which will be replied to is invited on all other matters pertaining to tropical agriculture, science and development.

WEST INDIAN AGRICULTURE.

Conference of Agricultural Officers.

IN our last issue we published a general account of the programme of the West Indian Conference of Agricultural Officers held recently at the Imperial College of Tropical Agriculture. In the present number this statement has been elaborated by publishing a number of addresses and papers read at the Conference and by giving a summary of its findings. The full Proceedings of the Conference will be published in due course as a separate report.

The Conference afforded, as similar West Indian Conferences have done in the past, excellent opportunities for those present to exchange ideas and opinions and to put forward proposals which, it is hoped, will help to further the development of agriculture in the West Indies and consolidate the excellent work that has already been done in these Colonies. During their stay at the College the delegates were given ample opportunities for conversing with members of the College Staff and of getting into touch with their activities. These conversations outside the formal meetings are part of the functions of any Conference, and always fulfil useful purposes in that they help to stimulate ideas and bring to light fresh points of view. The manner in which the position of the College in relationship to the Departments of Agriculture was emphasized should also have helped considerably towards fostering a spirit of co-operation between its officers and those of the Departments represented.

A great deal of time was devoted to the discussion of the development of the West Indian fruit and vegetable trade with Canada. At the present moment this trade, with the exception of bananas, is still in its infancy and before it can be successfully established, many agricultural and commercial problems will have to be solved. The discussions at the Conference were considerably strengthened by the presence of two eminent business men representing large fruit and vegetable interests in Canada. The first of these gave a precise account of the requirements of the Canadian fruit and vegetable trade, and showed that there was considerable scope for the West Indies to enter on that market provided they took steps to grow the right type of produce in sufficient quantities to ensure regular supplies. As much as 31 million dollars was spent by Canada on fruit and vegetables last year, and of that amount it was stated that an important percentage could

probably find its way to the West Indies. The other Canadian representative dealt chiefly with methods of packing and urged West Indian fruit growers to adopt the American as against the South African pack as it is more popular on American and Canadian markets. The delegates gave information on what their Colonies were already supplying in the commodities required and what they were likely to supply in the near future. From their answers it may be concluded that while exports of fruit and vegetables from the West Indies and British Guiana are small at the moment, with proper organisation and time they could be profitably increased. Both in Jamaica and Dominica organisations have already been set up for the co-operative marketing of fruit and if these prove successful, they might well be taken as examples by other West Indian Islands of what can be done. The Conference, after considerable discussion, laid particular stress on the desirability of producing commodities of uniform quality and recommended that vegetable variety trials should be undertaken to ascertain which varieties are likely to be most suitable for the Canadian trade. It also recommended the adoption of uniform methods of marketing, the establishment of some central sales agency in Canada and the closest co-operation between the Conference Colonies in the preparation and marketing of fruit and vegetables intended for export to Canada. These appear to be vital points in the proper development of the fruit and vegetable trade. Further recommendations included the establishment of packing houses and pre-cooling stations, the keeping of proper thermograph records on steamships, and the necessity for further research in refrigeration methods and in the utilization of surplus and waste products. Finally it was suggested that a Standing Committee should be appointed to act as a central agency for the distribution of information on the trade.

The discussions on soil research were mainly directed to the importance of crop ecology in the formulation of the agricultural policy of a colony. It was urged that soil and ecological surveys should be made in connection with colonization and other agricultural development schemes, as a preliminary to the settlement of peasants on the land. The broad principles of co-operation and the avoidance of duplication with regard to the programmes of experimental and research work were discussed not only at the Conference itself but during the intervals of its meetings, and generally approved. It was also suggested that where conditions permitted, the services of technical officers should be available for consultation, especially in matters pertaining to biological control and plant breeding, to all the islands and not only to the island in which these officers might be employed. With regard to the scope of agricultural economics in these Colonies, attention was particularly paid to the matter of rural finance and the organisation of credit societies for peasant cultivators. It was further agreed that the development of agricultural co-operation should form a subject for discussion at the next Conference.

Perhaps one of the most important steps taken by the Conference was the appointment of a Sub-Committee for discussing the standardisation of experimental trials. Extracts from their valuable report will be found in the present issue of the Journal. Their report urged the appointment of a permanent Field Experiments Committee which would be located in Trinidad and include, among other officers, a thoroughly qualified statistician. The need for such an officer cannot be over-emphasized as he could render invaluable services by interpreting experimental data and by giving advice for the future organisation of experiments.

Arising out of the discussion on problems of sugar-cane research it was suggested that the College should undertake the genetic side of this work as a line of investigation distinct from breeding, so as to facilitate the latter. The sugar-cane stations situated in Barbados and British Guiana are to be maintained as heretofore for the purpose of breeding commercial varieties of canes, as both these stations have been and are working under totally different sets of conditions. Particular stress was laid on the fact that the excellent work which had been done in Barbados should be continued and strengthened. With the object of having alternative varieties in reserve, in case of the failure of any existing commercial variety, it was advocated that systematic sugar-cane variety trials should be arranged. Finally, the formation of a West Indian Sugar Technologists' Association was approved.

On the last day of the Conference the report of a Sub-Committee appointed to go into questions of plant quarantine was discussed at some length and it was agreed that the establishment of a central quarantine station was desirable, but that its situation should be a matter for discussion by the Colonies concerned. As the subject of quarantine regulations was, however, found to be extremely complicated, the appointment of a Standing Committee to study its various aspects was suggested. The Conference's final recommendation was to indicate the desirability of appointing a Permanent Conference Committee whose duties would consist of giving effect to the findings of the Conference and of encouraging the closest co-operation between the several Departments of Agriculture and generally furthering their work.

This briefly summarises the work of the Conference. It will probably meet every three years in future, in Trinidad or alternatively in one of the major colonies, with a personnel which will continue to consist of Agricultural Officers. The Conference, it must be remembered, can only act in an advisory capacity and its recommendations will have to be passed by the Secretary of State before they can be put into effect. There is no doubt that it has thrown much useful light on a number of problems and particularly on the present state of the fruit and vegetable industry in the West Indies. Further it has aided in the general movement towards a "rapprochement" between the West Indies and Canada, a movement which deserves the full support of all those who have at heart the future agricultural prosperity of the West Indies.

WEST INDIAN CONFERENCE.

Opening Address

By His Excellency the Acting Governor, Mr. S. M. Grier, c.m.g.

It is now 30 years since the Imperial Department of Agriculture was formed, as a result of recommendations made by the Sugar Commission which visited the West Indies at the close of the last century, and a few Agricultural Conferences were arranged by that Department before the outbreak of the Great War. One such Conference was held in Jamaica in 1907, and was brought to an untimely end by the earthquake which took place while the Conference was actually sitting. The Conferences which were held before the war and the one organised by the Imperial College of Tropical Agriculture, in Jamaica six years ago, undoubtedly served a very useful purpose and were attended by planters and others interested in the agricultural development of the West Indies.

But I feel that the greatest debt that we owe to the Imperial Department of Agriculture is that it was largely responsible for the location of this College in the West Indies. There is, I think, an increasing realization throughout the West Indies, and Trinidad in particular, of the great value of the scientific research work which is being carried out in this College, and furthermore, an appreciation of the fact that we shall ultimately benefit by having at our doors an Institution where not only men from England, but also men from these Colonies, can be, and are being, adequately trained to take an active part in developing the agricultural wealth of our Tropical dependencies.

To-day, however, there opens a Conference of possibly a rather different character. The principal objective of this Conference is to bring into consultation Agricultural representatives from different parts of the West Indies for the purpose of co-ordinating the work which they are doing, and of comparing and profiting by the results of the experiments which each Department is carrying out.

It is difficult to over-estimate the potential value of this Conference, which I sincerely trust can be regarded as the first of a series of similar Conferences to be held every second, or at least every third year, for the purpose of linking up the efforts which are being made in different parts of the West Indies to solve problems which, in a number of instances, are common to several, if not to all of them, and there can be no more fitting venue for this inaugural Conference than the Imperial College of Tropical Agriculture.

I sincerely wish that this type of Conference had been organised as a regular institution a number of years ago. During the war, and for a period after the war, the great demand for the products of the West Indian Colonies caused a rise in the prices paid for those products, and induced a false sense of prosperity, which militated against adequate forethought being taken for the morrow. Conditions are far different to-day, and it is through adversity that the necessity for a sustained and co-ordinated effort to recover a fair measure of prosperity has been brought home to us. If, however, we have learnt our lesson and are determined to profit by it, I believe that we can look forward to the future in a hopeful spirit.

We cannot, however, disguise the fact that in this Colony we are faced with a serious threat to one of our main industries (I refer to cocoa), which we are ill-equipped to meet. Had, for instance, our Agricultural Department been adequately staffed in the past and been able to undertake in this island the study of soil conditions and the collection of data, which are now being attempted, we should have been in a far stronger position and been capable of coping with the existing situation with a greater assurance of success.

I have said that I believe that there is a growing realization of the value to the West Indies of the Imperial College of Tropical Agriculture, but I am not convinced that there is as yet an adequate realization of the great importance of strengthening our Agricultural Departments and of enlisting in them men who have been scientifically trained, not only to make the best practical use of the results obtained from the research work which is being conducted in this College, but also to carry out experimental work and to inculcate into planters, whether they be peasant proprietors or estate owners, an appreciation of the value of the advice given to them.

Not only do we need a closer co-ordination of effort among the Agricultural Departments of the West Indies, but also mutual confidence and co-operation between the planter and the departmental officer, if we are to make real progress, and I hope that this and subsequent Conferences will help to attain that result.

I should like to say how pleased we are that this Conference is being attended by Canadian representatives who are interested in the export to Canada from the West Indies of the fruit and produce which they can supply. All of us realise that the economic salvation of the West Indies depends largely on the development of their trade relations with that great Dominion. As far as Trinidad is concerned, efforts to develop an export trade in fruit have been so far of a very tentative nature, and I am afraid that in existing conditions they are likely to meet with little success, for it cannot be too widely realised in this island that our present system of handling our exports and the lack of adequate harbour facilities will militate seriously against the successful export not only of uncrated fruit, but also of some types of crated fruit.

This is not merely my personal opinion, but is a statement based on the advice given me by men who have the experience and knowledge which entitles their views to be accepted. Yet in

Trinidad at the present time we have the somewhat amazing phenomenon of men who state that they have convinced themselves, and who apparently are anxious to convince others, that the construction of a harbour which would lessen the cost of exporting our produce and would reduce the risk of its damage and deterioration to a minimum, is a scheme which would be inimical to the agricultural interests of this Colony.

Quite apart from the Gilbertian attitude of these gentlemen, I do regard it as a serious handicap to Trinidad that we are so ill-equipped at the present time, for a situation has arisen which may result in cocoa proving no longer an economic crop in parts of this island, and in it becoming necessary for planters to effect a change-over to some other crop. They may find themselves at a very serious disadvantage if that change-over has to take place, for the only crops which can be considered are those which our present methods will permit of being shipped in a marketable condition.

Gentlemen, I expect that you must regard an inaugural address as a depressing formality, and I have no desire to prolong this one, particularly as you have before you work of much importance and interest.

I do, however, appreciate the fact that it has fallen to my lot to extend a welcome to Agricultural representatives from a number of West Indian Colonies, who have come to a Conference which I regard as being of first importance, and I look forward to studying the results of their discussions with the greatest interest.

Chairman's Address.

By Mr. G. Evans,

Principal of the Imperial College of Tropical Agriculture.

The present Conference differs from former Agricultural Conferences that were held so successfully in the past under the Chairmanship of Sir Francis Watts, in that its members are to be Directors of Agriculture of the Caribbean Colonies, or Agricultural Officers, and Officers of the Agricultural Research Institute here at St. Augustine. The Conference has been specially called by the Secretary of State for the Colonies, and is a direct result of a resolution passed by the West Indian Standing Conference held at Barbados last January. The Secretary of State's letter appointing the Conference reads as follows:—

Sir,

I am directed by Mr. Secretary Amery to refer to the following Resolution on the subject of co-operation in agricultural matters which was passed by the West Indies Conference on the 30th January:

> "That this Conference having heard an address from Mr. G. Evans, Principal of the Imperial College of Tropical Agriculture, desires to express its conviction of the need of greater co-operation between the Agricultural Departments of the Conference Colonies, and recommends that each of the Governments of the Conference Colonies should appoint its Director of Agriculture, or failing him an Agricultural Officer, to attend a meeting to be held at an early date under the Chairmanship of the Principal of the Imperial College, with a view to devising means for co-ordinating local programmes of agricultural and veterinary research work, avoiding over-lapping between the Agricultural Departments of the various Colonies and maintaining close touch between the local Departments and the Imperial College."

2. Mr. Amery will be glad if the Governing Body will convey to Mr. Evans an invitation to undertake the task of convening and presiding over the proposed meeting and for that purpose to communicate direct with the Governments which are prepared to accept the recommendation contained in this Resolution. The Governors of the various Colonies have been requested to inform Mr. Evans of their decisions on this matter as soon as possible in order that he may proceed with the arrangements for holding the meeting at an early date, as recommended by the Resolution.

I am, Sir,

Your obedient Servant,

(Sgd.) L. B. FREESTON.

I have also received the following message from Lord Passfield, the present Secretary of State, which I have been requested to read to you:—

I have great pleasure in sending a message of welcome and greeting to the important Conference of Directors of Agriculture which is to be held in Trinidad. The West Indian Colonies, British Guiana, and British Honduras have many agricultural problems in common, and I feel that considerable scope still remains for closer co-operation between them. I believe that the Imperial College of Tropical Agriculture is fulfilling the hopes of its promoters by providing training and opportunities for research for those to whom we must mainly look for the improvement and development of tropical agriculture. I am glad that the Empire Marketing Board has been able to render substantial financial assistance to the College, and I hope that the readjustments now being considered will increase its usefulness.

I trust that among other matters this Conference will consider what arrangements can best be made for future Conferences for the improvement and co-ordination of research, for locating experimental work to the best advantage, and for the exchange of information and visits. It is a source of regret to me that certain Colonies have found it impracticable to send a representative to this Conference. I hope that at future Conferences every Colony concerned will be represented, as every unit has some contribution to make as well as some benefit to receive. Only by full and generous co-operation will be achieved to the greatest possible extent that which I have very much at heart, namely, the greater prosperity of those engaged in the industry of agriculture in this important part of the Empire.

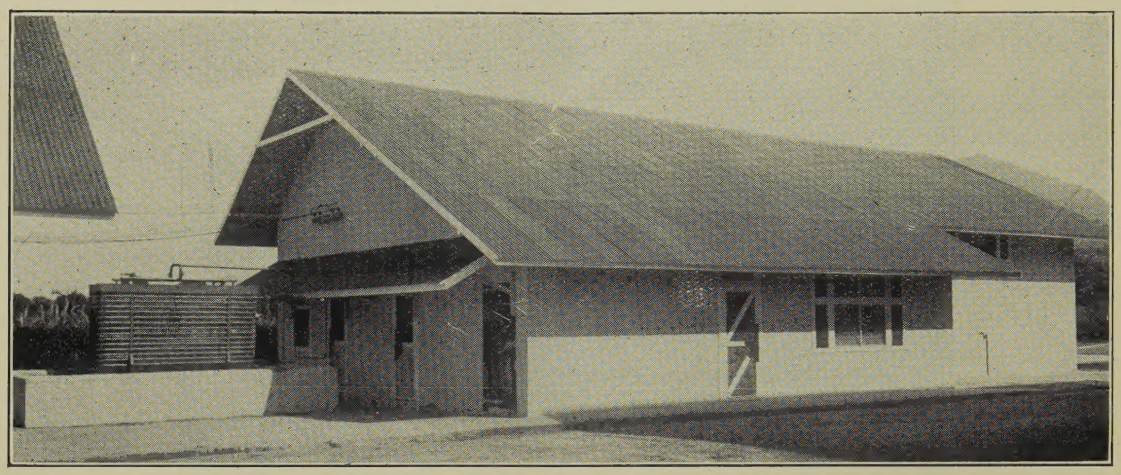
WEST INDIAN CONFERENCE OF AGRICULTURAL OFFICERS.

Photograph by *Tucker Picture Co.*

For names see page 100.

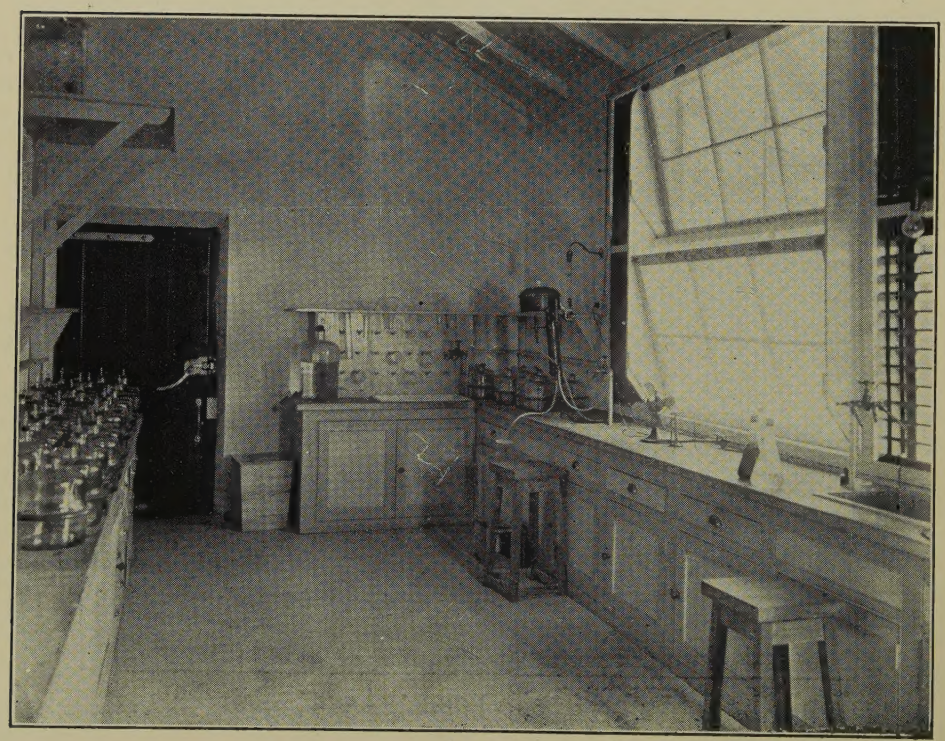
THE LOW TEMPERATURE STATION.

See page 108.



Photograph by *Tucker Picture Co.*

FIG. 1.—*The Banana Research Station. (The Ammonia Condenser is shown on the left.)*



Photograph by *Tucker Picture Co.*

FIG. 2.—*Physiological Laboratory, showing entrance to the Air Lock.*

The President of the Standing Conference of the West Indies is, as you are probably aware, Sir Edward Davson, and he also has been good enough to send me the following message, that I should like to read out to you :—

DEAR MR. EVANS,

I am very glad to learn that the Conference of Directors of Agriculture is to be held on 23rd January, and that the Directors from so many Colonies have signified their intention of being present. I know that attendance at the Conference must entail a certain amount of interruption of work and sacrifice of time to all but I am glad that the Colonies concerned have nevertheless shown such public spirit in responding to your invitation.

I look upon the forthcoming Conference as one of the most important in the agricultural history of the British West Indies and I feel sure that under your Chairmanship it will have fruitful results.

The need of co-operation and the pooling of resources is evident in almost every industry at the present time and this need also applies to the scientific direction which must naturally take a large share of the responsibility of the development of our agricultural industries. You are aware how those who are interested in the subject are working here to this end and how scientific bureaux to deal with all sides of agricultural science are being successively formed. Much, however, of the opportunity of making use of these aids to scientific progress will be lost unless there is a corresponding co-operation among the agricultural departments overseas.

I know that each department has its own particular problems to solve and its own local conditions to deal with, but nevertheless I feel that the correlation of work, the exchange of ideas and, in fact, the pooling of brains, will further assist towards the end which we all have in view. This end, I need hardly say, is the improvement of agricultural conditions in these Colonies.

I therefore take this opportunity of wishing the Conference all success.

Believe me,

Yours very truly,

(Sgd.) EDWARD DAVSON.

Both these messages emphasize the need for co-operation and the pooling of resources so far as scientific agriculture is concerned, and it is interesting to note that as regards the Colonial Office, the agricultural policy seems to be in the direction of grouping the Colonies together. For instance, a Conference of Agricultural Officers was held at Nairobi for the East African group about three years ago ; last autumn, as you know, a Conference of the Agricultural Officers of the West African Colonies was held in the Gold Coast, and now we have a similar Conference for the West Indies.

I have had a somewhat difficult task in arranging for this Conference, because our Colonies in the West Indies are so scattered, and communications are consequently a matter of time. I should have liked to have been able to arrange for more time for discussions, but our dates are strictly limited by the steamer services. It is possibly this question of time that has prohibited the attendance of any officer from Jamaica, since as you know, direct communications between that Colony and Trinidad are few and far between. Jamaica has co-operated in so far as it has submitted its programme of experimental work. The Governments of British Honduras and the Bahamas have both signified their complete sympathy with the objects of the Conference. The Agricultural Department of the former Colony, however, consists at present of a single Officer only, and he naturally could not be spared, as there would be nobody to act for him in his absence. The Bahamas have no Department of Agriculture, although, I understand, proposals are now being discussed with the object of forming one.

The other Colonies are all represented, and I should like to take this opportunity of welcoming here, in particular, the Director of Agriculture of Bermuda, as this Colony has not hitherto been grouped with the Caribbean Colonies. He has made a long journey, and I am sure at considerable inconvenience, and he will bring with him information that should assist us greatly in some of our deliberations.

I have mentioned already the tendency of the Colonies to group themselves together as geographical units when discussing matters of common interest. So far as the Caribbean group is concerned, there is one instance in which their agricultural policy is bound to be profoundly affected, and in which there is a difference from the other groups of Colonies in the Empire. I refer to the establishment of the Imperial College of Tropical Agriculture in this region.

This College is a new Institution, and has only been working for about seven years. Its establishment is due to the economic pressure that has arisen since the war. The more rapid development of the agricultural resources of the tropical portions of His Majesty's Empire became a self-evident fact, and led to the appointment by His Majesty's Government of several important Commissions. The decision to establish a College of Tropical Agriculture in Trinidad was the result of a recommendation made by a Government Committee presided over by the late Lord Milner. Included in the personnel of this Committee was the late Sir Arthur Shipley, who was the first Chairman of the Board of Governors, and who did so much for tropical agricultural research. Now the development of this College has been extremely rapid, and it has had various extra functions added to it from time to time. Starting purely as a West Indian College, it rapidly became involved in a wider sphere, when it was entrusted with the training of Agricultural Officers for the whole of the tropical Colonies in the Empire. Its functions, as I have indicated briefly in the memorandum you have before you, are training and research. The training portion of our work consists of a Diploma Course, in which West Indian agriculture is taught, and a Post-Graduate Course, in which a wider training is given to enable students to be fitted for their responsibilities as Agricultural Officers and Agricultural Specialists in other parts of the

Empire as well as in the West Indies. Part of their training consists of research methods, and this course therefore fits in very well with the research programme of the College.

Turning now to the Research side of the College, it will be noted that the main crops we are dealing with—cacao, sugar-cane, bananas, and limes—are all West Indian, as perforce they must be, as for the purposes of our research we have to grow crops well suited to the locality. You will notice, however, that they are in reality being used as indicators, and that our underlying programme consists of fundamental research into problems of soil science, genetics and cytology, economics and other cognate sciences connected with agriculture. The College is also growing a wide range of other crops, especially annuals, and we are doing this because it is necessary for our teaching work. So far as our research policy is concerned, we are endeavouring to follow the recommendations elaborated by the Committee presided over by Lord Lovat, with which, probably, you are all familiar. This Report of Lord Lovat's Committee endeavoured to lay down the appropriate functions of a Central Research Station such as this is on the one hand, and those of a Colonial Agricultural Department on the other. Briefly stated, it has recommended that the Research Station should deal with fundamental and long-range research, and that the Department should deal with experimental work and the application of results by demonstration, organization and similar means. It further pointed out that the work of an Agricultural Research Station should be supplementary to that of a Department, and could in no way be regarded as a substitute for it.

Now this division of work sounds perfectly simple on paper, but it is not quite so straightforward in practice, and I consider that one of the chief objects of this Conference should be to give an opportunity to Officers of the Agricultural Departments and Officers of the College Departments to discuss their respective programmes fully. The College programmes have been carefully thought out, and are now beginning to be put into operation. So far as we believe, they are not going to clash with the legitimate work of an Agricultural Department, but in one or two instances we have already modified the scope of schemes to fit in with the wishes of an Agricultural Department. As an example, I might mention that the original Cacao Scheme, which was drawn up, with the full cognisance of the then Director of Agriculture, Trinidad, was afterwards submitted to the Gold Coast and Nigerian Departments, and modified somewhat to suit their wishes. The final referee in this case was the Agricultural Advisory Council of the Colonial Office, a newly constituted body. One or two other matters on our research programme have since been referred to it for opinion also.

I mention these matters, as I am sure that you will agree with me that it is only right and proper that a thorough understanding should be a rived at as soon as possible. To further this desirable state of affairs, you will have the opportunity, during your stay at the College, of examining and discussing in detail the various College programmes of research with the appropriate Officers on the Staff, and it is for this reason that a discussion of experimental programmes has been placed on the Agenda. Two other important matters bearing on this subject, namely, soil research and sugar-cane breeding, will also form the subjects of discussion.

There is another function of the College that I feel I must mention, and that is the advisory work. When the College was started, it absorbed the old Imperial Department of Agriculture and undertook to carry on the work of that body. The fact, therefore, that extension work in the Leeward and Windward Islands is at present part of the duties of the College, may be considered as in the nature of an historical accident. The Governing Body of the College have naturally felt it their duty to carry out their pledges in this respect, and up to the present have been endeavouring to cope with this work by the appointment of one of the Professors as Commissioner of Agriculture in addition to his other duties. Experience has proved, however, that this is not sufficient, and last year a further step was taken by creating a post of Assistant Commissioner to help him. This question was gone into very carefully by Mr. F. L. Engledow, who last year was appointed by the Empire Marketing Board as a Commissioner to enquire into the finances and future policy of the College. His recommendations, which have been approved by the Governing Body, are now under the consideration of the Empire Marketing Board and the Secretary of State. Mr. Engledow recommends the strengthening of the staff of the Commissioner of Agriculture, and an extension of the work of the Advisory Department of the Imperial College. The additions to the staff would consist of an Agriculturist, with special training in marketing methods, a Soil Chemist, and a Pathologist. I mention this development, as although people may consider that this is not really the work of an Agricultural Research Institute, you will realize, for the present at any rate that the Governing Body have found it necessary to carry out this policy, as they have definite obligations in this respect to fulfil.

Turning to the other subjects on the agenda, I have selected those that appeared to me to be of interest and importance to all the Colonies represented. I received several other useful suggestions, but our time is so limited that it has been necessary to confine the number of subjects for discussion.

The Canadian trade in fruit and vegetables is a matter that is of interest to all the Colonies directly or indirectly. It is a new development, and is a direct result of the inception of the magnificent new service that has been started by the Canadian National Marine, as the outcome of the Canadian-West Indies agreement. The Agricultural Departments are naturally anxious to assist this new development, and the time is now ripe for the officers of the various Agricultural

Departments concerned to get together in order to pool their knowledge and to arrange for a definite policy, particularly in regard to standardisation of varieties, grades and packages. I take it that Canada would like to deal with the West Indies as a whole, and not with individual Colonies so far as this trade is concerned. The industry is still in its infancy, and its potentialities are of great import to the Islands, but the organisation of the trade requires the most careful consideration at this stage If mistakes are made, the whole movement may be retarded, since the production is, to a considerable extent, in the hands of the small holder and peasant—a class who naturally cannot afford big losses, and who are consequently easily discouraged.

A consideration of plant quarantine regulations is of interest to all. It is of particular importance nowadays, since, with the rapid improvement of transport methods, numerous exchanges of produce and introductions of new varieties are taking place, and the risk of introducing new pests and diseases is consequently increased. Among new pests and diseases which threaten us, I need only mention the Witch broom of cacao, Gummosis in sugar-cane, and the Mediterranean Fruit Fly, which has now appeared in Florida. It is, of course, important and necessary that we should be in a position to try out new varieties of crops from other parts of the world, but their introduction should not be haphazard, but carefully planned. I should like particular attention to be paid, therefore, to the subject of quarantine stations and to the control of importations. I propose to refer this matter in the first place to a Committee under the Chairmanship of Professor H. A. Ballou, the Commissioner of Agriculture at the College, and will ask you to assist me in nominating a Committee to help him, before we leave this afternoon. I should also like your opinion as to whether we should include animal quarantine rules. Veterinary matters are within the scope of this Conference, and if, in your opinion, this subject can be profitably included in the terms of reference of the Committee, it would be perhaps as well to do so. I have put down a discussion on cattle breeding for one afternoon, as I think that the experiments that are being carried out at the Government Stock Farm by the Trinidad Department, will prove of real interest to all of us, and may act as a useful guide for future developments in stock raising.

Now, gentlemen, there is another point that I have been asked by the Secretary of State to put before you, and I cannot do better than read his letter, which has just been received, and which I have not had time to circulate :—

SIR,

I am directed by Lord Passfield to inform you that the Colonial Advisory Council of Agriculture and Animal Health have had under consideration the preliminary arrangements which should be made for the Imperial Agricultural Research Conference which is to be held in Australia in 1932.

2. The enclosed papers, which have been received from the Ministry of Agriculture and Fisheries, explain the present position as regards the arrangements for the Conference. It will be seen that certain suggestions have already been put forward from the point of view of the Colonial Empire, and the Council will consider, in due course, whether any special items should be added to the Agenda for the Conference on behalf of Colonial delegates.

3. On the recommendation of the Council, the Secretary of State has already approved a proposal that a Colonial Agricultural Conference should be held in Ceylon in advance of the main Conference in Australia, and the observations of the Government of Ceylon on this proposal are now awaited. The Secretary of State is advised, however, that early opportunities should be taken to secure from groups of Colonies suggestions for items which might be recommended for consideration at the Imperial Conference, and I am to request that you will arrange for this question to be discussed during the Conference of Directors of Agriculture which is to be held in Trinidad in Janary, 1930, and will forward, in due course, any resolutions, or suggestions, which the Conference desire to submit.

4. It is contemplated that the special questions relating to tropical agriculture will be considered in conference in Ceylon and officers there selected for presenting before the main Conference in Australia the considered views of Colonial delegates on the several items of Colonial importance.

I am Sir,

Your obedient Servant,

(*Sgd.*) R. V. VERNON.

I propose to discuss this matter on the last day, and would ask you to give it your serious attention during the next few days and to come forward with suggestions, so that we may be able to forward definite proposals to the Secretary of State.

I would also like your views as to whether this Conference should be repeated, and if so, at what intervals, and this also we will take up on the last day. The views of the Colonial Office are expressed in a letter I have just received from Mr. Darnley, the Under Secretary of the West Indian Department.

Finally, I would beg to remind you that this Conference has no executive powers. As the result of our discussions, however, I trust and believe that we shall be able to put forward recommendations to the Secretary of State, and to the local Governments' that will be of great value to them in framing their agricultural policies.

The Trinidad Department of Agriculture, as you will observe from a perusal of the programme, are co-operating very heartily to make the Conference a success, and I am sure that we all wish to thank them for the arrangements they are making with regard to the proposed visit to the Government Stock Farm and River Estate.

The Cotton Research Station Officers are also anxious that you should have the opportunity of visiting the scene of their important investigations.

Before I sit down I should like to take the opportunity, on behalf of myself and my colleagues on the Staff, of welcoming to the College all the Departmental Officers who are attending the Conference. We are very gratified that the College has been selected as the site for this important Conference, and I wish to assure you that all members of the College are anxious to make your stay here as pleasant and profitable as possible.

SOIL RESEARCH AT THE COLLEGE.

[*Being an Address delivered on 25th January*, 1930, *by Mr. F. Hardy, Professor of Chemistry and Soil Science, at the West Indian Conference of Agricultural Officers.*]

I.—Introductory; the Scope of Crop Ecology.

THE present programme of soil research at the College is the outcome of a series of events, both in the history of soil science and in the history of this Institute and of its forerunner, the Imperial Department of Agriculture in the British West Indies.

When Sir Francis Watts, Imperial Commissioner for Agriculture, appointed, in 1920, to his staff in Barbados, a plant physiologist and a soil chemist, it had been generally recognised that many problems concerning crop production belonged to the domain of the physiological ecologist, and not entirely to that of the agriculturist or the plant pathologist. The advances which had been made in the science of crop ecology during the early years of the twentieth century had furnished the plant investigator with a fresh view-point, and with means of exploring quantitatively both the growth of plants and the various environmental factors controlling plant growth. This particular aspect had been stressed in a monograph by Sir John Russell, entitled *Soil Conditions and Plant Growth*, published in June, 1912. Since the first edition was issued, the subject has grown so rapidly that four revised editions of this book have appeared, the last (5th edition) in 1927. As Sir John Russell states in his preface to the fourth edition (1921), "The most striking feature of the past ten years' developments has been the increasing recognition of the complexity of soil phenomena; the American investigations have shown how complex are the physico-chemical relations of the soil, the soil-solution, and the plant; the English work has shown that the soil population is numerous and very varied. It is not sufficiently recognised, however, that *this complexity necessitates a difference in method of investigation* from that usually adopted in scientific laboratories."

It is apparent from these remarks that the training of the crop ecologist must be very broad. Crop ecology is usually defined as "the study of crop plants in relation to their environment." It comprises methods and means of approach to a large part of detailed botanical knowledge; it is not necessarily a special branch of botany, for the methods of crop ecology are mainly physical and chemical, and its results are generally amenable to statistical interpretation. Furthermore, the particular study of the composition, genesis and transformations of soils includes geological, mineralogical and meteorological considerations. Thus, the crop ecologist must be able to apply to the study of plants and soils, the precise quantitative methods of the physicist, the chemist, the mineralogist, and the mathematician.

When such plant and soil studies were initiated in the British West Indies by the Commissioner for Agriculture in 1920, four important features of crop ecology were emerging. They were, firstly, the significance of soil reaction (acidity and alkalinity) in relation to plant growth; secondly, the inadequacy of previous methods of chemical soil analysis; thirdly, the importance of the colloidal aspect of soil physics; and lastly, the importance of climate in relation to soil genesis and soil character.

(1) *Soil Reaction.*

Detailed investigations of soil reaction relations were made possible by the invention of precise new methods for measuring the intensity factor in soil acidity and alkalinity. The basis of these methods was the *hydrogen electrode*, an instrument of great accuracy, that yielded results which could be expressed on a definite scale of values, known as the pH scale. By means of this instrument, the colour changes in certain new *indicator substances* could be given numerical expression, so that field investigators, to whom access to the hydrogen electrode was denied, could at least employ indicator methods of much greater precision than was previously possible by the use of litmus paper. More recently, the hydrogen electrode has been replaced in most soils laboratories by the cheaper and less difficult *quinhydrone electrode*, by means of which determinations of soil reaction may rapidly be made, even by untrained workers.

(2) *Chemical Soil Analysis.*

That the older methods of chemical soil analysis are of little value in ecological studies, was amply demonstrated in certain critical investigations undertaken at the University of California in 1914-1922. These and other similar investigations finally proved (*a*) that there is no consistent relation whatever between crop yield and (*i*) the total quantity of any chemical element present in the soil, or (*ii*) the quantity of any element soluble in hydrochloric acid, or (*iii*) the quantity soluble in citric acid, excepting within very wide limits. They did prove, however, that the amounts of plant nutrients (especially nitrate) *extracted by water* were definitely related to crop yield. Soil samples taken fortnightly throughout several growing seasons, showed marked fluctuations in the quantity of water-soluble nutrient present. This further important finding indicates that, in performing chemical studies of soils, it is necessary periodically to collect and examine a large number of soil samples. This enormously increases the work of the soil analyst. Fortunately, however, by utilizing a simple electrical conductivity apparatus, a sufficiently accurate measure of the concentration of water-soluble plant-nutrients may be made in a very short space of time, and the values obtained may afterwards be amplified where thought necessary by simple specific chemical determinations. A further important advance in chemical soil analysis has been furnished by studies of the easily available nutrients

(exchangeable basic and acidic radicles) by a standardised technique, which has, in recent years, become well established in most soils laboratories. We are now in a position, therefore, to explore the soil environment of plants with a much greater degree of accuracy than has heretofore been possible. The application of the newer methods should at least create a greater confidence in the service which the soil investigator can offer to the practical plant grower in the study of his crops, both in health and in disease.

(3) *Soil Physics.*

Whilst advances in soil chemistry during the past 20 years have been phenomenally rapid, they have been almost equalled by the progress made in the parallel study of soil physics. The old "sand-grain and water-film hypothesis" of the nineteenth-century soil physicist, which furnished the basis of soil science as propounded by most writers of agricultural text-books, has recently been profoundly modified by considerations of the important part played by the colloidal components of soils. Thus, in the preface to the third (1917) edition of his monograph, Sir John Russell announced that "a new chapter discussing the colloidal properties of the soil" had been added; "the soil investigator of the future will have to be thoroughly familiar with the ways of colloids," and "much of the older work will require careful re-examination in the light of what has been done in this direction by chemists and physicists."

Perhaps the most striking feature of the successful application of modern colloid science to the study of the soil, is the increased knowledge gained of physical factors which control soil moisture supply, as well as the structure and behaviour of soils when tilled in the field, and when treated with certain ameliorants such as lime and manures. As an outcome of the work of Livingston in the United States of America, new methods for directly measuring the water-supplying ability of soils in the field, have been elaborated for application to crop problems.

(4) *Soil Genesis.*

Finally, the work of the Russian School of Soil Science on the genesis of soil-types, has been made available to the whole world through recent translations, and through the proceedings of the newly-formed International Society of Soil Science, whose first President was the late Dr. K. D. Glinka of Leningrad. The detailed study of undisturbed soil-sections in Russia indicated that characteristic profiles have been produced by the long-continued exposure to climatic factors, particularly rainfall and temperature, of parent rock material of diverse sorts. The recognition of such profiles was made possible in Russia, because, in that vast country, lines of equal rainfall and of equal temperature run parallel to each other, so that the effect of one factor augments that of the other. Furthermore, the Russian Continent is geologically so very old that ample time has been afforded for climatic factors to act so as to overwhelm the mineralogical factors presented by the initial parent rock. The generalizations revealed by detailed studies in this new branch of soil science (now known as pedology) have been successfuly applied to the soils of many other countries, and have altered the whole aspect of soil classification and soil mapping.

II.—Progress of Soil Science in the British West Indies.

In the British West Indies, an attempt to apply the newer teachings and methods of soil science was first made by the writer in Dominica (December, 1920). Certain soils, growing cacao and limes, were examined for soil reaction by means of improved colorimetric indicators of known pH range. The results were considered in relation to soil genesis and to the fertility of the soils with respect to these crops (2). Some general considerations of soil acidity and of liming were also discussed in two articles that were published about this time (1), (3).

In the following year (April, 1921), Dr. T. G. Mason (Plant Physiologist) and the writer made a preliminary ecological study of the lime crop in Montserrat, with particular respect to the factors causing die-back (4). It was suggested, as an outcome of this work, that die-back of limes is a physiological affection induced mainly by excessive fluctuations in available soil water.

During the period May, 1921, to August, 1922, soil work was mainly continued in the Leeward Islands Government Laboratory, where, through the courtesy of Mr. A. E. Collens, facilities were afforded for the study of some of the properties of colloidal soils collected mainly in Montserrat and Antigua. This work was later described in several papers, published in 1923 (5), (6), (7), on the subjects: soil shrinkage, water retaining capacity, and the measurement of water-supplying power of soils. This work in soil physics was continued during 1923 and 1924, in Trinidad, at the newly-founded West Indian Agricultural College. It culminated in the publication of further articles on cohesion and percolation in colloidal soils (8), (9). The newer chemical aspects of soil science (particularly base exchange in soils) were studied by Mr. P. E. Turner, who joined the staff of the chemistry department in 1924. During the early days of the College, an extensive course on crop ecology was drawn up for presentation to post-graduate students who came to the College in increasing numbers after the Empire Cotton Growing Corporation and the Colonial Office had decided to utilize its facilities for the training of their tropical agricultural officers.

III.—The Froghopper Problem.

The opportunity of applying the newer knowledge and methods of crop ecology to a definite field problem arose when the writer was appointed Chairman of the Scientific Committee for the further investigation of the problem of froghopper blighting of sugar-cane in Trinidad, in succession to Mr. W. Nowell (Assistant Director

of Agriculture) who left the Colony in July, 1926. Mr. Turner (Lecturer in Chemistry) had already been seconded to that Committee as Soil Chemist, his place on the teaching staff of the Chemistry Department being taken by Mr. H. H. Croucher, who arrived in Trinidad in October, 1926. In the little time available for research, Mr. Croucher has investigated some fundamental problems in the physical chemistry of soils (19), and has tested certain new methods of soil analysis, with particular reference to tropical laterites. Mr. G. Rodriguez, who had been appointed Chemical Analyst in 1926, rendered valuable aid in much of the laboratory routine connected with the froghopper investigation. Mr. R. R. Follett-Smith, Assistant to the Chairman of the Scientific Committee, from August, 1926 to March, 1929, and previously a Post-Graduate student at the College, performed most of the biochemical work in connection with the ecological examination of the sugar-cane plant growing in different environments.

The importance of soil relations in the general problem of froghopper blight had long previously been stressed by Mr. C. B. Williams in his Memoir (1921), but no detailed investigations had been attempted. The classical observation was that canes growing on certain red acidic soils in the Naparima District of Trinidad, periodically suffer severe froghopper damage, whilst canes growing on neighbouring black, alkaline, calcareous-marl soils, usually escape blighting. Actual measurements of the degree of acidity and alkalinity, by means of the quinhydrone electrode, have recently completely substantiated this relationship for a large number of soil samples collected in the Naparima District. The value of such detailed work only became really apparent, however, when an attempt was made to extend the reaction theory of blighting to the alluvial cane-soils of the central and northern plains. These soils all belong to one type, and have similar appearance in the field, yet canes growing on them exhibit different degrees of blight resistance. It was therefore necessary to take soil samples from almost every field of the central and northern sugar estates, and to note the reputation of each field as regards froghopper blighting. Some 3,000 soil samples were collected, and their reactions determined in the laboratory. Textures were also assessed as a single-value constant, by a simple method devised by the writer (17). The results further established the correlation that apparently exists between degree of acidity and susceptibility to blighting, regardless of texture, topographical position, and soil type. This generalization received greater definition when the lime status of selected representative samples of cane soils was determined by Mr. Turner (14), (24), (18). There seems little doubt that the soils of areas liable to froghopper blight are lacking in combined lime (exchangeable calcium), and are therefore acidic in reaction. The *reason* for this relationship, however, is not yet understood.

IV.—The Mechanism and Effects of Liming.

The recognition of the reaction and lime-relationship in the froghopper problem was naturally followed by a detailed investigation of the effects of liming. Soils that had been limed in the past, yet had apparently not shown any improvement, were especially examined. In nearly all cases it was demonstrated that the liming had been inadequate, or that the added lime had not sufficiently combined with the soils (13), (25). Special liming trials were consequently inaugurated in different sugar estates; two of these, devised by Mr. Turner, are large-scale quantitative trials of fundamental importance. For the purpose of guiding estates' managements in the selection of fields for liming, a lime-deficiency map of the cane-growing area has been constructed. It necessitated the elaboration of a new rapid electrometric method for measuring the lime-requirements of soils (23).

V.—Ecological Studies of the Sugar-cane.

Concurrent with these soil studies, the effect of growth conditions, both soil and atmospheric, on the biochemical composition or "quality" of the sugar-cane plant, was investigated in "good" and "bad" plots selected at three different stations. The results of this work have been described in several articles by Mr. Follett-Smith and the writer (15), (20), (21), (22), (26), (27) (29).

They are linked up with various manurial trials that have recently been inaugurated, for growth conditions affect, not only those properties of a crop generally designated "healthiness," but also its yielding capacity.

VI.—Cacao and Forest Soil Investigations.

It is clearly evident from the foregoing account of our work on sugar-cane soils in Trinidad, that the methods of soil study largely depend on the particular objects in view (31). This general principle is further illustrated by our investigations of cacao and forest soils, which present entirely different aspects. Cacao and forest soil problems were first attacked in October, 1928, primarily with the object of furnishing problems for post-graduate students.

The chief feature which characterises cacao and forest soils, and contrasts them with sugar-cane soils, is their natural stratification as seen in profile. The undisturbed surface soil contains the humified residues of roots, leaves, twigs and flowers, and merges imperceptibly into non-humic layers of varying composition, and finally into the unweathered parent rock. In Trinidad, the parent rock of the regions where cacao and forest occur belongs to many different types. The distribution of these rock-types has been determined in great detail by oil geologists, whose maps and field data have recently been compiled in a book by G. A. Waring. Furthermore, the botanical composition of the forest flora of Trinidad and Tobago is being systematically recorded by the officers of the Forestry Department of the Colony. With this available evidence, several soil problems may confidently be defined. For example, answers to the following questions

are being sought: (1) What characteristic profiles are displayed by the soils overlying the different geological formations represented in Trinidad and Tobago? (2) How far does the mineralogical composition of these rock formations affect the soil profile? (3) To what extent have climatic factors (such as rainfall and temperature) modified the mineralogical influences? (4) What ecological relationships exist between soil-type and forest flora? (5) In what respects do good cacao and good forest soils differ from bad? (6) What soil changes occur when forest lands are brought into cacao cultivation, and cacao lands into cane cultivation? (7) What soil changes occur in these lands when brought into peasants' cultivations? (8) What agricultural and manurial treatments are likely to benefit such lands as are brought into cultivation to various specific crops? (9) What should be the procedure in soil-sampling for the purposes of a detailed survey of undisturbed lands? (10) To what extent would detailed soil surveys be of service in the formulation of land settlement policies?

It is not necessary to stress the fundamental importance of these various problems, for they lie at the root of all schemes of land utilization in the tropics, and the methods and results which should emerge from their systematic investigation ought to be of general application in other countries.

Progress so far has been slow. We have nevertheless been able to describe some 110 soil profiles, and to collect and examine some 1,200 soil samples. For each soil sample, reaction, index of texture ([17]), organic matter content ([30]), and rate of solution of the more readily-available nutrients, have been determined. The results are pictorially represented in columns of colours for each profile, thus facilitating subsequent comparison.

We have been greatly aided int his work by the co-operation of the Trinidad Forestry Department, the College Department of Economics, and cacao planters. More rapid progress will later be possible, when a grant awarded for this work from the College Cacao Research Fund becomes available.

List of Publications on Soil Science.

(*Arranged in Chronological Order.*)

1. Soil Sourness, its Meaning and Significance. *West Ind. Bul.*, XIX, 1921, p. 38.—F. Hardy.

2. The Soils of Dominica, their Genesis and Fertility considered in relation to Reaction. *West Ind. Bul.*, XIX. 1921, p. 86.—F. Hardy.

3. Liming, a Means of Soil Amendment.—*West Ind., Bul.*, XIX, 1922, p. 161.—F. Hardy.

4. The Soils of Montserrat, their Natural History and Chief Physical Properties, and the Relationship of these to the Problem of Die-back of Lime Trees.—*West. Ind. Bul.*, XIX, 1922, p. 189.—F. Hardy.

5. The Physical Significance of the Shrinkage Coefficient of Clays and Soils. *Journ. Agr. Sci.*, XIII, 1923, p. 243. —F. Hardy.

6. The Maximum Water-Retaining Capacity of Colloidal Soils, the Interpretation of this and of Certain Other Soil Moisture Constants. *Journ. Agr. Sci.* XIII, 1923, p. 340.—F. Hardy.

7. The Soil Point Method for directly estimating the Water-Supplying Power of a Soil in the Field. *Journ. Agr. Sci.*, XIII, 1923, p. 355.—F. Hardy.

8. Cohesion in Colloidal Soils. *Journ. Agr. Sci.*, XV, 1925, p. 420.—F. Hardy.

9. Percolation in Colloidal Soils, considered in relation to Cohesiveness. *Journ. Agr. Sci.*, XV, 1925, p. 439. —F. Hardy.

10. Anomalous Flocculation in Colloidal Soils. *Journ. Phys. Chem.*, XXX, 1926, p. 254.—F. Hardy.

11. The Rôle of Aluminium in Soil Infertility and Toxicity. *Journ. Agr. Sci.*, XVI, 1926 p. 616.—F. Hardy.

12. The Measurement of "Suction Forces" in Colloidal Soils. *Soil Sci.*, XXIV, 1927, p. 71.—F. Hardy.

13. The Liming Problem in Trinidad Sugar-cane Soils. *Proc. Frogh. Cttee.*, I, 1927, p. 202.—F. Hardy.

14. The Lime Status of Trinidad Soils, and its Relation to Froghopper Blight. *Proc. Frogh. Cttee.*, I., 1927 p. 292.—P. E. Turner.

15. The Effect of Some Growth Conditions on Chemical Composition and Metabolism in the Sugar-cane Leaf. *Proc. Frogh. Cttee.*, I, 1928, p. 331.—R. R. Follett-Smith.

16. The Slaking of Dry Soils with Water. *Journ. Agr. Sci.* XVIII, 1928, p. 41.—K. T. Hartley.

17. An Index of Soil Texture. *Journ. Agr. Sci.*, XVIII, 1928, p. 252.—F. Hardy.

18. An Investigation of the Method of Page and Williams for the Determination of the Saturation Capacity of Soils. *Journ. Agr. Sci.*, XVIII, 1928, p. 257.—P. E. Turner.

19. Dye Absorption by Hydrous Alumina in Soils. *Journ. Agr. Sci.*, XVIII, 1928, p. 250.—H. H. Croucher.

20. The Nutrient Status of the Observation Plot Soils. *Proc. Frogh. Cttee.*, II, 1928. p. 145.—R. R. Follett--Smith.

21. A Comparison of the Hydrophilic Colloid Content of Sap of Leaves of Sugar-canes growing in Good and in Bad Soil. *Proc. Frogh. Cttee.*, II, 1928, p. 158.— R. R. Follett-Smith.

22. Variation in Chemical Composition of Sugar-cane Leaf due to Different Conditions of Insolation. *Proc. Frogh. Cttee.*, II, 1928, p. 165.—R. R. Follett-Smith.

23. A. Rapid Electrometric Method for Measuring, "Lime Requirements" of Soils. *Journ. Agr. Sci.* XIX, 1929, p. 17.—F. Hardy and A. H. Lewis.

24. The Lime Status of Soils in Relation to an Insect Pest of Sugar-cane. *Journ. Agr. Sci.*, XIX, 1929, p. 26.—P. E. Turner.

25. Liming as a Factor in the Amelioration of Deteriorated Tropical Soils. *Journ. Agr. Sci.*, XIX, 1929, p. 83.—P. E. Turner.

26. Soil and Caneleaf -Moisture Studies of the Observation Plots. *Proc. Frogh. Cttee.*, II, 1929, p. 188.— F. Hardy and R. R. Follett-Smith.

27. The Water-Supplying Power of Certain Trinidad Sugar-cane Soils. *Proc. Frogh. Cttee.*, II, 1929, p. 212. —R. R. Follett-Smith.

28. Soils of Trinidad Sugar Estates: (1) Soils of the Central Plain. *Proc. Frogh. Cttee.*, II, 1929, p. 243.— F. Hardy.

29. Some Results of an Ecological Investigation of the Sugar-cane. *Refer. Book of Sugar Indus. of the World*, 1929, p. 20.—F. Hardy.

30. A Note on the Determination of Soil Organic Matter. *Journ. Agr. Sci.*, XIX, 1929, p. 737.—F. Hardy.

31. Some Aspects and Methods of Soil Survey Work. *Journ. Agr. Sci.*, XIV, 1929, p. 734.—F. Hardy.

GENETICS AND BREEDING.

Cane Variety Problems of the West Indian Region.

[*Being a Paper submitted at the West Indian Conference of Agricultural Officers by Mr E. E. Cheesman, Professor of Botany and Genetics.*]

CANE seedling work, having literally saved the sugar industry in the last decade of the last century, has retained a high place of honour in West Indian popular estimation ever since. Elsewhere, it is recognized in all the progre sive cane countries of the world to be one of the most important of the lines of scientific investigation which lead to progress in the sugar industry, and the reflection of that universal approbation helps very much to strengthen the local attitude and to support local efforts in sugar cane breeding.

Nevertheless, it is felt that the time is opportune to enquire dispassionately just what cane breeding is at present doing for West Indian Agriculture, and more particularly whether the best is being done that can be done, and what may be expected from this line of work in the future. In such a critical enquiry, we may be helped by the adoption of some standard of comparison. There has lately been a widespread interest shown in the scientific work of the Dutch in Java, probably stimulated in the first place by the appearance and acclamation of P.O.J. 2878, and accentuated by the recent International Conference of Sugar Cane Technologists, at Soerabaja. In the popular estimation, at least, Java is accepted as the most "scientific" cane-growing country in the world, and I propose therefore, to point to a few contrasts between the work done there and that done in the West Indian region. The differences may be considered under three main heads, as differences of magnitude, differences of organisation, and differences of varieties used.

So far as the differences of magnitude are concerned, it is well known that the Experiment Station at Pasoeroean, dealing with all aspects of the sugar industry, has a budget and staff about three times as large as those of the Imperial College of Tropical Agriculture. To keep to cane breeding, their 1927 programme included 450 different crosses, and in 1928 they planted out from a smaller number of combinations 70,000 seedlings. They keep a variety collection of 4,000 varieties of cane, which is entirely replanted every year. These are indications of work on a much bigger scale than we adopt in the West Indies, and with all due respect to the very able staff of the Java station, it seems safe to assume that where they are ahead of us their success is at least partly due to the size of their operations and the money which they have available for their work.

There is a lesson in that for us, but it is evidently not simply to work on the same scale, because that would be impossible. An industry producing over 2½ million tons of sugar annually can obviously afford a bigger research scheme than one producing barely one-seventh of the amount. The lesson is partly to work on as big a scale as possible, and partly so to dispose our efforts as to obtain maximum efficiency, and thus reduce the handicap of small size.

This brings us to the differences of organization, and in that respect we have undoubted y something to learn from Java. The point needs no elaboration, because every one familiar with the publications of the East Indies organisation is aware that it works as one unit, and our whole agenda suggests an attempt to get sugar research in the West Indies working as one unit likewise.

Leaving the agenda for fuller discussion a little later, we may complete our comparison by noting the not unimportant differences between the breeding material we use and that used in the East. These differences arise from the fundamental fact that in order to combat sereh disease the Dutch breeders started their programme with the combination of what they call the "noble" canes with varieties of the wild species *Saccharum spontaneum*. Their subsequent work has been essentially a continual back-crossing of the hybrids to noble canes, and they do not seem by any means to have yet reached the useful limits of the "ennobling" process.

In the British West Indies, breeding has been almost restricted to a fairly narrow circle of noble canes, and it is a serious question whether, by neglecting to a great extent the much wider range of material available in other parts of the world, we are not missing opportunities which might be exploited. I do not suggest that we should necessarily follow the Java method to the extent of using *S. spontaneum*, but I have purposely spoken of cane *variety* problems rather than cane *breeding* problems, because it is possible that among the wealth of forms which exist there may be some as good for certain of our conditions as anything we can breed. It would be feasible, for example, that among the hundreds of Indian varieties there may well be canes which would beat Uba under the conditions which render cultivation of that type necessary, and it is even more probable that there are many which would cross with our local canes to give us better hardy types for our poorer soils.

In this connection, I would like to mention that Professor Scott, who has recently returned from Java, has been in communication with Dr. F. W. Zerban, General Chairman of the International Federation of Sugar Technologists. The information received emphasises strongly the importance of variety collections, and suggests a piece of work which we should be very glad to take up. The consideration of it throws us back on the question of organisation, because introduction on a large scale and observation of introductions is obviously work which must be centralised for economy.

Turning now to the specific items of our agenda, I propose to invert their order and take number three first, because I visualise the College scheme of genetic research as the keystone of any reorganization which may be attempted. Our aim is to stand behind the breeding stations,

not only of the West Indies but of the Empire, and support them with information, and to some extent raw material, for their work. Such a scheme appears to contain our only hope of getting level with our bigger competitors. A certain amount of fundamental research, especially in cytology, is being done in Java, but no country has yet an institution engaged primarily upon such work as we contemplate. Such fundamental work as is being done is being done on the breeding stations themselves, and though in a few cases they are useful centres, they are on the whole not ideal for the purpose.

The College programme has been explained in a memorandum which was drawn up in April, 1928, and about the same time I dwelt at some length on the differences between cane breeding and cane genetics in an article in the *Agricultural Journal of British Guiana,* Vol. I, No. 2, 1928. It will be seen that our aim is essentially to obtain information which will guide breeding operations along quicker and more certain channels.

A central problem which we propose to tackle is the connection between hybrid constitution and vigour, a point of first importance in the breeding of all cross-fertilized plants, and one which is at present rather obscure. Other points which we might hope to elucidate are (1) the range of variation shown by established varieties under varying conditions. This would tell us what units to adopt in measuring and judging seedlings. Probably there is at present an enormous wastage every year of good seedlings on account of improper standards of rejection, and some of that we might learn to prevent; (2) the relative importance of the factors which go to make up yield; (3) the factors which contribute to high sucrose content, and their relative importance; and (4) the correlation, if any, between yield and sucrose content.

It will readily be appreciated that none of these questions can be successfully answered by officers busy with the practical aspects of breeding. On the other hand, the data obtained on breeding stations would be of enormous value to the research geneticists. For this reason, and for others which will occur to you, it becomes obvious that a prime essential for success in the attack on cane variety problems is the closest contact and co-operation between the genetic and breeding stations, contact indeed so close that the two sides form virtually a unit organization. Their separate parts of a common programme can be fairly well defined, but there must be a certain amount of border-line work where mutual goodwill and understanding are vital for efficiency.

So we come to the first and second items of our agenda. It is for this Conference to decide whether the cane seedling work of the whole of this region could not be done on one station with greater effectiveness than it at present attains on any one of several. So far as the genetic side is concerned, it would be vastly easier to co-operate effectively with one breeding station than with several, and so far as the breeding side is concerned the concentration of staff and funds could hardly fail to be beneficial.

The only argument against centralization which needs discussion at all is that the climates and requirements of the different colonies differ too widely to make it possible to raise canes in any one of them suitable to all the others. It would appear doubtful whether the range of conditions in the West Indian region is greater than that in Java, which uses a central station, and it is certainly less than the range served by Coimbatore, which embraces the whole of India. We are probably all prepared to admit the advantages on theoretical botanical grounds of extreme localization of breeding, but the immediate issue is less botanical than economic. We are less than one-seventh the size of Java, and we have to husband our resources. There are admittedly advantages from the breeder's point of view in having a range of climatic conditions at his command, *if* he can utilize them. In Java they have sub-stations at different elevations which enable them to make crosses which are impossible at Pasoeroean itself on account of the peculiarities of arrowing habit of some varieties. In this region such a line of attack is less easy, because our constituent parts are separated by sea and communications are relatively difficult. We are therefore driven in any case to try to attain similar ends by different methods, and these involve technical manipulations much better done on a large and well-equipped station.

In favour of centralization, we have to remember that the chief advantages are those of personnel. It probably costs little more to raise one thousand seedlings in each of ten places than it does to raise ten thousand in one place, but the difference between ten isolated observers and a compact breeding staff at the same total cost is incalculable.

Besides this, it has also to be remembered that the raising of seedling canes is only part of a wider series of operations properly called cane breeding. Field testing of varieties, an equally essential part of the process, must be localized. Can it not be argued that relieved of seedling work, which is appropriate for centralization, local staffs might profitably devote more of their time and resources to the trial of varieties supplied to them from the central station? If such tests were standardised, as suggested by the second point of our agenda, they would give invaluable information to the officers responsible for genetics and breeding, and the staffs carrying them out would feel that they were all working as useful contributors to the common scheme.

This factor of joint contributions to a common scheme is to my mind the one essential for the success of an organization such as we have now to discuss. It would appear inevitable, under existing conditions, that the genetic and breeding sides should be prosecuted in different Colonies, for the genetic work cannot be divorced from the College in Trinidad, and Barbados as the largest

of the existing breeding stations suggests itself as a natural centre for the applied work. This separation must be frankly recognized as a handicap to close contact, but there are three factors which might contribute to reducing it to negligible proportions. They are mutual goodwill, ample travelling facilities for the investigators on both sides, and some form of joint administration. The first I think we need not question, and the others I suggest as suitable points for the present discussion.

AGRICULTURAL ECONOMICS.

[*Being an Address delivered on 27th January*, 1930, *by Mr. C. Y. Shephard, Professor of Economics, at the Conference of West Indian Agricultural Officers.*]

1. A definition of Agricultural Economics.

In the limited time at my disposal it is impossible for me to give more than a very brief outline of the work of this Department. At the outset, however, I feel it desirable that I should make an attempt to describe the subject matter of agricultural economics. As the name suggests, it is the application of the general principles of economics to agriculture. Agriculture, though never satisfactorily defined, may be considered as the production of useful vegetable or animal products, while economics may be described as a study of the material welfare of mankind. We therefore arrive at a general conception of agricultural economics as a study or science which is concerned with the material welfare of agriculture. It remains for us to define clearly the scope and activity of the agricultural economist as distinguished from other workers associated in any way with agriculture.

Agriculture may be considered as a science, a craft, and a business. The science of agriculture concerned as it is with those factors which influence the biological activities of plant and animal organisms embraces Botany, Chemistry, Mycology, Entomology, &c. The craft involves the application of this scientific knowledge to agricultural practice, with the object of securing a profit. While the translation of scientific knowledge into agricultural practice is the task of the scientist, the attempt to secure a profit is the concern of the economist. The difference in attitude can be illustrated quite simply. The scientist is interested to know whether an application of manure will result in increased production. The agricultural economist, on the other hand, desires to know whether the application of manure gives an increased profit. The scientist is concerned with physical volume and quality, and the agricultural economist with profit. The business aspect of agriculture which corresponds roughly to marketing, as the craft does to cultivation, is the concern of the economist alone. Agricultural economics may be described comprehensively as the application of economics to the craft and business of agriculture.

2. Value of Agricultural Economics.

It is clear that agricultural economics embraces a wide range of studies affecting the welfare of agriculture in general and the individual agriculturist in particular. The agriculturist, either individually or in combination, can exert very little influence on the price of his products and he is compelled therefore to consider methods of lowering his costs of production as the principal means of increasing his profits. This accounts for the large number of "cost studies" being carried out by agricultural economists. The importance of these investigations need not be stressed since agriculture is, after all, primarily a business. When the possibility of profit making permanently ceases then the interest of the agriculturist in agriculture also ceases. It is the aim of the individual to organise his resources in the manner which will secure the highest possible profits. Economic studies dealing with the individualistic, as contrasted with the community, aspect of agriculture, are known as "farm management." The agricultural economist attempts by the analysis of individual estates to establish standards by which the agriculturist can assess his own results and introduce such modifications in his organisation as appear both possible and desirable.

3. Method of Research.

We must next consider how the economist undertakes his investigation. Economic research differs from scientific research in at least one important aspect. The scientific research worker uses laboratory methods and may avail himself of experiments carried out under controlled conditions. To the economist, this method is denied and perforce he has to study the farm as a "going concern." His observations are seldom based on experimentally arranged conditions. Economic research is based, therefore, upon a survey of, or insight into, the organisation of individual farms.

Three principal methods have been evolved:

(1) Cost Accountancy;
(2) Financial Accountancy;
(3) The Survey.

(1) *Cost Accountancy.*

The Cost Accountancy method seeks, by the detailed analysis of the individual farm, to discover opportunities of economising materials or effort. It involves the keeping of elaborate records by the farmers throughout the year, and the analysis of these records by the economist. Its advantages over other methods lies in the greater detail obtained.

Its significant disadvantage lies in the fact that it entails a considerable amount of work on the part of both farmer and economist, with the result that only a limited number of accounts can be completed and analysed. Owing to the diversity of conditions, it is difficult to apply general conclusions obtained from such limited sources. For these reasons Cost Accountancy is tending to give way to the other methods.

(2) *Financial Accountancy.*

This method consists in the analysis of the annual receipts and expenses of various farms. It enables a sufficiently large number of farms to be analysed to enable the averages to be used as guides, and enables the individual to compare his own record with the results for the group which most closely represents his own peculiar conditions. The strong and weak points of the organisation of the individual producer are thus revealed. This method is becoming increasingly popular because it is cheaper than cost analysis, and gives more accurate results than the Survey method.

(3) *The Survey Method.*

The Survey method involves the examination and comparison of a large number of farms of similar type, with the object of isolating certain features associated with success or failure, and to show how these may be developed or modified in individual farms. Even when accurate records are not kept, it is claimed that the average of a group is fairly reliable, and since a very large number of farms can be visited, it is also claimed that the data are more representative of the average conditions of the area than those obtained by either Cost or Financial Accounts.

Scope of Department Work.

With this preliminary explanation, we may now consider the research programme of this Department. We have attempted to make our work conform to the following requirements:—

(1) That the results, while of local interests, should be of interest or have application in a wider area.

(2) That the methods should make some contribution to the study of general agricultural economics, technique or method.

(3) That the studies should provide material both for teaching purposes and for students problems.

(4) That full advantage should be taken of the presence and co-operation of scientists on the College Staff.

While it was inevitable that we should be concerned with the principal staples of the island in which the College is situated, namely, sugar and cacao, opportunity has also been taken of carrying out studies in other Colonies (1). Some work has been carried out on the subject of:

(1) Co-operation.
(2) The Sugar Industry.
(3) The Cacao Insdustry.
(4) Agricultural Labour.

(1) *Co-operation.*

Our first piece of work was concerned with a study of co-operative systems, particularly those concerning credit in Trinidad, Tobago, St. Vincent, St. Lucia and British Guiana.

Our object was to ascertain why systems had been successful in some Colonies and unsuccessful in others. Our study emphasised the need for a preliminary economic study of the peculiar conditions of each Colony, in order that the co-operative system might be adapted to suit it, and the need for the societies being advised by an officer with co-operative experience.

A general account has been published (2) together with a study of the co-operative marketing of cacao in Trinidad (3). A considerable amount of other information is available in noted form, and can be discussed with anyone interested in the subject.

(2) *The Sugar Industry.*

Our preliminary descriptive survey (4) copies of which can be supplied to any interested member, is being followed up by a labour study (*see* below) and a survey of the cane-farming industry (available in note form).

(3) *The Cacao Industry.*

As with the sugar industry, a preliminary descriptive account (5) is being used as the basis for a more detailed statistical survey. The method employed is a combination of the Financial Account and Survey methods, in that we aim at covering a large number of estates, but rely upon accurately kept records, which are not, however, based upon a uniform system.

So far we have examined about 150 estates, and expect, by the end of the present College Session, to have completed over 200 records. These will be analysed first, district by district, and then for the whole island. The tables compiled from the analyses will show in detail the cost of production for the average of all the estates, and a selected number of the best and the worst. The method of presentation will enable each planter to compare in detail his own estate with (*a*) the average of all the others, (*b*) the best and (*c*) the worst, surveyed in the district. The data will also lend themselves to a comparison with all the other districts, and within the island as a whole.

Then we propose to classify and average all the estates according to certain similar characteristics, *e.g.*, rainfall, soil type, intensity of cultivation, age of cultivation, size, yield per acre, &c., in an attempt to assess the influence of these factors upon the financial success or failure of the estates.

There can be little doubt as to the merits of such a survey or to its usefulness to the individual planter. This survey is regarded as a preliminary investigation to others of a similar nature. Our programme includes the following pieces of work, which will be undertaken as our resources permit.

(1) An economic survey of those cacao properties whose records are not sufficiently detailed or accurate for our present purpose. This was commenced by Mr. G. Wright, but had to be abandoned when he left the staff. In this work we co-operated very closely with the officers of the Trinidad Department of Agriculture.

(2) The extension of the present survey to cover a period longer than the present one (three years), which will eliminate the effect of seasonal variations in rainfall, yields, price, and other disturbing influences.

(3) A similar survey of the cacao industries of Tobago and Grenada.

(4) An examination of field records. This method would correspond roughly to the Cost Accounting method described above. Mr. Wright was engaged on this line of investigation, but was unable to complete his work before he left. At present we have a number of estates keeping such records on a form devised by Mr. Wright in co-operation with the planters. It will be extended to other estates after it has been modified in accordance with experience. This will obviate delay when we are ready to commence work.

(5) The examination in further detail, in co-operation with other Departments, of those factors which our present survey indicates are of particular importance, *e.g.*, soil, intensity of cultivation, age of cultivation, &c. We have already, for example, obtained considerable assistance from Professor Hardy and his Staff, in connection with cacao soils.

(6) An economic survey of the coconut estates of Trinidad.

(4) *Labour.*

At the request of a number of estates, we undertook, in 1928, with the assistance of Messrs. Fraser, Sanders and Turner, Post-Graduate Students, an investigation into the labour situation in Trinidad. Fortnightly records have been regularly received since then from about 100 cacao estates. These figures are now being analysed. As an account of the work so far done is available in typescript, I need not detain you with further reference to this piece of work.

As an outcome of this work, Dr. Seagar, in co-operation with the writer, and with the assistance of Captain Wingate and Mr. Hayes, Post-Graduate Refresher Course Students, 1928-29, undertook to examine medically the individual labourers for whom we had records of days worked and wages earned, and to examine their diets. These data are now being analysed. A preliminary account of the dietic aspect has recently been published, by Dr. Seagar in *Tropical Agriculture.*

This, gentlemen, represents the research programme of the Department of Economics. While it may appear ambitious, we must remember that it is a programme which will require many years to complete. It is only by planning carefully in advance that we can avoid dissipating our energies. We have invariably received the cordial support and co-operation of the various Departments of Agriculture, particularly that of Trinidad in which Colony we have naturally carried out most of our work, and I have no doubt that these happy relations will continue under the Directorship of Mr. Wortley. The success of our work depends to a very large extent upon the co-operation of planters and in this connection we have been particularly fortunate. Their willingness to assist us makes Trinidad an ideal Colony for carrying out agricultural economic investigations, and I hope that with the further accumulation of data important scientific and practical results will emerge.

In conclusion may I say that if any Department desires to undertake any of the research embraced in our programme or to carry out investigations of a similar nature, we shall be delighted to extend to them that full measure of assistance which we have invariably received.

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CONFERENCE PHOTOGRAPH.

We publish on page ix, a group which was taken at the College on the first day of the West Indian Conference of Agricultural Officers.

Standing left to right:—C. Y. Shephard, Professor of Economics, I.C.T.A.; F. Hardy, Professor of Chemistry and Soil Science, I.C.T.A.; G. A. Jones, Assistant Commissioner of Agriculture for the West Indies, I.C.T.A.; G. Gianetti, Editor-Librarian, I.C.T.A., and Secretary to the Conference; Dr. A. E. S. McIntosh, Geneticist, Department of Agriculture, Barbados; Dr. E. A. Seagar, Professor of Tropical Sanitation and Hygiene, I.C.T.A.; F. C. Harcourt, Superintendent of Agriculture, Dominica; S. M. Gilbert, Assistant Director of Agriculture, Trinidad; E .E. Cheesman, Professor of Botany and Genetics, I.C.T.A.; E. A. Walters, Superintendent of Agriculture, St. Lucia and the Windward Islands; H. R. Briton-Jones, Professor of Mycology and Bacteriology, I.C.T.A.; R. C. Wood, Professor of Agriculture, I.C.T.A.; and J. de Boissière, A.D.C.

Sitting left to right:—C. de Verteuil; E. A. McCallan, Director of Agriculture, Bermuda; G. Moody-Stuart; Professor J. S. Dash, Director of Agriculture, British Guiana; His Excellency the Acting Governor, Trinidad; G. Evans, Principal, I.C.T.A., and Chairman of the Conference; R. W. R. Miller, Director of Agriculture, Barbados; H. A. Ballou, Professor of Zoology and Entomology, I.C.T.A., and Commissioner of Agriculture for the West Indies; A. E. Collens, Superintendent of Agriculture, Leeward Islands; Sir Henry Walcott.

FIELD EXPERIMENTS.

On Sugar-Cane.

[*The following is an extract from the Report of a Sub-Committee appointed by the West Indian Conference of Agricultural Officers to consider the standardisation of the lay-out of field experiments. The Report is to be published in full in the Proceedings of the Conference.*]

THE field experiments outlined be ow may usefully be divided into two types :—

(1) The empirical or survey type, consisting of a straightforward comparison of yield for a number of different treatments or varieties.

(2) The more fundamental, analytical type, which aims in the first place at determining the general effect of certain definite factors and their interaction on yield. This aim is achieved by arranging that the treatments compared shall represent every possible combination of the factors under investigation. The generalisations, particularly as to interactions, emerging from such experiments, are likely to have a wide range of application, and should possess fundamental as well as local significance. In experiments of this type the nu nber of different treatments may be large and, in consequence, the number of replications possible may be smaller than in the survey type of expe: iment. With the exception, however, of finer interactions, the results are based on averages of several treatments taken at a time, and therefore possess a smaller experimental error than the number of absolute replications would suggest.

In the survey type, the number of replications can usually be made equal to the number of treatments, and the Latin Square lay-out employed. In the analytical type, this is not usually possible, and the method of randomised blocks is preferable. Where the blocks are large, control of field heterogeneity may not be very close, but it is possible in certain cases to sub-divide blocks into comparable sub-blocks for the better control of this source of error (*see* Experiments IV and V). In other cases, where special importance is attached to one particular factor, this factor may be investigated by the use of sub-plots, varying only in respect of this particular factor, on each of the main plots (*See* Experiment Ia, Modification II, Experiment Ib, Experiment VII (*a*); also Wishart, J., and Clapham, A.R. (1929), *J. Ag. Sci.*, XIX, 600.)

The maximum amount of information which it is possible to derive from the schemes outlined below, cannot be obtained unless there are many replicates of each block. As a rule three or four replicates are suggested as the minimum, but such a number may be insufficient, even when the effects of the factors investigated are large.

I.—Variety Trials with Sugar-Cane.

Experiment I.

The varieties are sub-divided into three groups :—

E. Early Maturing (for late planting).
M. Medium Maturing.
L. Late Maturing (for early planting).

The simple lay-out given below should enable a very accurate comparison to be made of the varieties within each group, and at the same time a valid, if less close comparison, between different groups. It assumes a fixed growing period for each group.

Lay-out.

Two specimen blocks are given. There should be at least four blocks in the series if possible.

E_2	E_4	L_3	L_4	M_4	M_1
E		L		M	
E_1	E_3	L_1	L_2	M_2	M_3
L_4	L_2	M_2	M_1	E_2	E_3
L		M		E	
L_3	L_1	M_3	M_4	E_4	E_1
M_3	M_4	E_3	E_1	L_2	L_1
M		E		L	
M_2	M_1	E_4	E_2	L_3	L_4

E_3	E_4	M_3	M_4	L_2	L_4
E		M		L	
E_2	E_1	M_1	M_2	L_1	L_3
M_2	M_4	L_2	L_4	E_2	E_3
M		L		E	
M_1	M_3	L_3	L_1	E_1	E_4
L_3	L_1	E_2	E_3	M_2	M_1
L		E		M	
L_4	L_2	E_4	E_1	M_4	M_3

Area of Plots.—One-twentieth to one-tenth acre for estate conditions.

It would be advantageous to include B.H. 10 (12) (or in British Guiana, D. 625) in all three classes, *i.e.*, as an example of an early, medium and late maturing cane.

If the time of planting is suitably varied, the time of reaping could be the same for all varieties.

It is doubtful whether the information at present available is adequate for the classification into three such groups of the cane varieties in common use. An experiment which involves every combination of the two factors, variety and time of reaping, therefore appears desirable.

Experiment I (a).

Where, as may be the case on experiment stations, the plots are small and can be reaped at different times without interference with neighbouring plots, the method of randomised blocks can be used with advantage, *e.g.*, if *n* varieties are under examination, and there are three times of reaping, there would be 3*n* plots in each block.

Modification I.

Only one plot of each variety in each block, but each plot to be sampled at three different times. If the same area of land is used as in Experiment I (*a*), such a modification should give a smaller standard error for estimating the effect of time of reaping, but a larger standard error for estimating the effect of variety.

Modification II.

An approximately similar result could be obtained by sub-dividing each variety plot into sub-plots, to be reaped at different times. The specimen block given below illustrates the type of lay-out which would then be used. The position of the sub-plots with respect to one another is determined by random choice.

Specimen Lay-out for nine varieties (1-9) to be reaped at three different times (T_1, T_2 and T_3). There should be at least four replicates of this block. The position of the plots in each replicate should be drawn at random.

T_1	T_2	T_3
T_3 4 T_2	T_1 9 T_3	T_1 7 T_2
T_2	T_2	T_1
T_1 5 T_3	T_3 1 T_1	T_2 6 T_3
T_3	T_2	T_2
T_1 2 T_2	T_3 3 T_1	T_1 8 T_3

Experiment I (b).

Where, on the other hand, the plots are large and are reaped as in estate practice, it might be impossible to reap neighbouring plots at different times without damage. To meet this difficulty, two alternatives are suggested :—

(1) There would be in each block one plot for each time of reaping, this plot being divided into sub-plots, one sub-plot for each variety. The three large plots, one for each time of reaping, would then form a block, which should be repeated at least four times. The arrangement of the sub-plots within each plot, and of the plots within each block, should be determined by random choice. Under these circumstances, the effect of variety would be estimated with greater accuracy than the effect of time of reaping.

Specimen Lay-out. (One block only is shown.)

Three times of reaping T_1, T_2 and T_3). Nine varieties (1-9).

T_3			T_1			T_2		
4	9	2	5	8	4	2	1	7
5	1	7	7	9	3	8	4	6
8	6	3	1	6	2	9	5	3

(2) The combinations of variety and time of reaping might be arranged as in the ur modified lay-out for Experiment I (*a*) (*i.e.*, 3*n* plots per block), but the canes planted at different times, to allow reaping on the same day. The information thus gained would, of course, be qualitatively different from that given by the other method.

II. Spacing trials with Sugar-cane.

Experiment II.

I.—A simple experiment designed to estimate the effect of spacing distance on any one variety.

The distance between plants in a row and the distance between rows are treated as two distinct factors. Three intensities are chosen for each factor, and these are combined in all possible ways.

The details of this experiment are arranged for 24-foot beds, but they can be adapted to suit other beds of other widths.

1.—*Planting Distances.*

No. of plants in row.

6 (= 4 feet apart.)	(1)
12 (= 2 do.	(2)
24 (= continuous planting.)	(3)

Distance between rows.

3 feet.	(*a*)
4½ do.	(*b*)
6 do.	(*c*)

2.—*Plot Treatments.*

(1) 1a	(4) 1b	(7) 1c
(2) 2a	(5) 2b	(8) 2c
(3) 3a	(6) 3b	(9) 3c

3.—*Lay-out.*

The nine combinations to be scattered at random in a block. There to be a minimum of four blocks. Area of plots one-twentieth to one-tenth acre for estate conditions.

4	9	2
5	1	7
8	6	3

5	8	4
7	9	3
1	6	2

2	1	7
8	4	6
9	5	3

3	7	1
5	2	9
4	6	8

4.—The information obtained can be set out as follows :—

(*a*) *Major Effects.*

(1) Average effect of plant distance.

[Comparison of the three means, *i.e.*, $m_1 = \left(\frac{1a+1b+1c}{3}\right)$, $m_2 = \left(\frac{2a+2b+2c}{3}\right)$, and $m_3 = \left(\frac{3a+3b+3c}{3}\right)$.]

(2) Average effect of row width.

[Comparison of the three means, *i.e.*, $m_a = \left(\frac{1a+2a+3a}{3}\right)$, $m_b = \left(\frac{1b+2b+3b}{3}\right)$, and $m_c = \left(\frac{1c+2c+3c}{3}\right)$.]

With four blocks, these means will each represent means of 12 plots.

(*b*) *Interactions.*

Comparison of yields from individual treatments with those expected from the average effects of (1) planting distance, (2) row width.

5. The yield data could be arranged to show the major effects and interactions as under :—

Observed Yields per acre.

	a	*b*	*c*	Mean.
1	y_1	y_2	y_3	m_1
2	y_4	y_5	y_6	m_2
3	y_7	y_8	y_9	m_3
Means	m_a	m_b	m_c	M

Expected Yields if no Interaction.

Y1	Y2	Y3
Y4	Y5	Y6
Y7	Y8	Y9

Interactions, *i.e.*, Deviations from Expected Yields.

y_1-Y1	y_2-Y2	y_3-Y3
y_4-Y4	y_5-Y5	y_6-Y6
y_7-Y7	y_8-Y8	y_9-Y9

y_1, y_2, &c., are mean yields per acre for the treatments 1*a*, 1*b*, &c.

M = mean of all.

$Y1 = m_1 + m_a - M$. $Y2 = m_1 + m_b - M$, &c.

The existence of any significant interaction is determined by observing whether the sum of the squares of the deviations is greater than would be expected from the magnitude of the experimental error.

II.—It is desirable that spacing experiments be carried out with more than one variety, and the interaction between spacing and variety ascertained. Where row width is constant and planting distance alone varies, the lay-out could be similar to that given below.

Experiment I I (a).

Five varieties (1 to 5).

Three planting dstances (a, b and c).

Row width constant.

1.—*Combination of factors.*

1. 1a.	6. 1b.	11. 1c.
2. 2a	7. 2b	12. 2c
3. 3a	8. 3b	13. 3c
4. 4a	9. 4b	14. 4c
5. 5a	10. 5b.	15. 5c

2.—*Specimen Block.*

14	9	5	10	15
3	6	1	4	13
2	7	8	12	11

There should be at least four replicates of this block.

Where variety interaction is to be investigated, and both row width and plant distance in the row is to be varied, the total number of combinations will be very large. It is therefore suggested that either :—

(*a*) There be one large plot for each variety in each block, each plot being divided into sub-plots, one for each spacing combination, or

(*b*) There be one large plot for each spacing combination in each block, each plot being divided into sub-plots, one for each variety.

Both types of lay-out would give an accurate measure of the interaction between spacing and variety, but the former would measure the average effect of spacing more accurately than the average effect of variety, and the latter the average effect of variety more accurately than than that of spacing.

(*To be continued.*)

COCOA IN 1929.

DURING recent years the world's supply of cocoa has increased in a remarkable degree, and, although the consumption of cocoa has shown healthy expansion, it has not generally kept pace with the production, so that prices have tended to become cheaper. In 1928 there was a rather sharp drop in values but in the past year market conditions showed some improvement, and prices moved within narrower limits. The following table shows spot quotations in London :—

	African West Coast.	*Trinidad good to fine.*	*Ceylon good to sup.*
31st December, 1925	43/0 to 45/0	66/0 to 73/0	90/0 to 100/0
31st December, 1926	70/0 to 71/0	78/0 to 80/0	80/0 to 87/0
31st December, 1927	62/0 to 65/0	74/0 to 77/0	85/0 to 93/0
31st December, 1928	48/0 to 52/0	61/0 to 66/0	95/0 to 114/0
31st March, 1929	49/0 to 52/0	65/0 to 70/0	90/0 to 110/0
30th June, 1929	46/0 to 50/0	62/0 to 63/0	80/0 to 90/0
30th September, 1929	46/6 to 49/0	62/0 to 65/0	85/0 to 90/0
31st December, 1929	43/0 to 48/0	62/0 to 65/0	85/0 to 96/0

The drop in prices of Ceylon cocoa last year represents a return to normal production, prices having risen in the preceding year owing to a short crop. The world production of cocoa in 1929 is estimated at about 527,000 tons, against 513,000 tons in 1928. Of the 1929 total the Gold Coast provided about 235,000 tons, against 220,000 tons in the preceding year: Nigeria, 55,000 tons, against 50,000 tons; Trinidad, 26,000 tons (about the same quantity as in the preceding year); and Bahia, 62,000 tons against 72,000 tons. World consumption in the past year is estimated to have increased by about 50,000 tons compared with 1928, the total being placed at 500,000 tons. The greater part of the increase was due to expansion in the United States, which is estimated to have absorbed 200,000 tons, against 164,000 tons in 1928. Some increase in consumption was recorded in the United Kingdom, as will be gathered from the following figures from the Board of Trade returns :—

Raw Cocoa.	**1926.** *Tons.*	**1927.** *Tons.*	**1928.** *Tons.*	**1929.** *Tons.*
Imports	59,461	64,057	63,329	77,406
Home consumption	56,409	55,847	55,566	57,496
Re-exports	9,314	4,490	7,224	10,685
Stocks in bond on 31st December, 1929 ..	17,950	20,950	21,600	31,750

An interesting development during 1929 was the formation of the London Cocoa Trade Association, the chief objects of which are to encourage the consumption of cocoa and to co-operate with scientific effort to improve the quality of cocoa. It also proposes to establish uniformity in regard to contracts and to create machinery for arbitration and the settlement of disputes—(*Times Annual Commercial Review.*)

TROPICAL WORLD NOTES.

Uganda.

According to the Colonial Report* for 1928 the year was one of partial recovery after two depressing incidents of 1927—the low price and production of cotton and the lack of rain. Both had an adverse effect on the revenue of the Protectorate and the latter was the cause of famine in several districts. The total value of the domestic exports, however, represented an increase of 46.96 per cent. Cotton maintained its predominant position in the list of commodities exported from the Colony, the total exports exceeding in value those of 1927 by £784,489. There was also a considerable increase in the value of cotton seed exports.

As in the preceding year, a period of four weeks from the beginning of the cotton-buying season, which opened in January, was prescribed during which no raw cotton other than "good" could be bought or sold in all districts in the Eastern and Buganda Provinces. This regulation again had a beneficial effect in raising the average standard of the lint exported. In Buganda the ginning firms combined to form an association for the purchase of raw cotton in the Province, and this combination handled the bulk of the crop. The objects of the association as explained by those responsible for its formation were to reduce costs of buying, ginning and transporting cotton and to pay a fair price to the producer. Similar associations have since been formed in the Eastern Province. These associations have given rise to considerable controversy and are regarded with some suspicion by native producers, and "middlemen" buyers are definitely antagonistic to them.

The acreage under *coffea arabica* grown by non-natives remained at approximately the same figure as in 1927 but this type of coffee is gradually being replaced by *coffea robusta* in the lower and more humid parts of the country. The native coffee industry made steady progress during the year and large numbers of plants of *coffea robusta* were issued to growers from central nurseries. This is the variety of coffee which is encouraged in the Buganda Province and in the low-lying Bwamba County of Toro, and work on the selection of the best types has occupied the attention of the Department of Agriculture.

The experimental work in connection with the establishment of a tobacco industry was continued and several European planters have experimented with this crop both in Bunyoro and in Buganda. Some excellent crops have been grown. Natives in Bunyoro showed great interest in tobacco and, under the supervision of the Department of Agriculture and of a representative of the British American Tobacco Company, raised a crop of approximately 50,000 lb. of cured leaf, which was purchased by the British American Tobacco Company for use in their cigarette factory established during the year at Jinja.

* Uganda *Colonial Report* No. 1439, 1928.

The year was remarkable for the rapid development of air traffic in Eastern Africa, and though the experimental stage is not yet entirely passed, it seems safe to predict that the trial flights undertaken in 1928 will lead to the establishment of a regular mail and passenger carrying service between Great Britain and the Cape, which will include Uganda in its route.

* * *

British Honduras.

The productive industries of the Colony in order of importance are: forestry, agriculture, and fisheries, the percentage value of exports for these industries in 1928 being 86 per cent., 13 per cent. and 1 per cent. The dominating character of the exports of mahogany (*Swietenia macrophylla* King), cedar (*Cedrela mexicana* Roem.) and chicle in the category of forest produce, and of coconuts, copra, and bananas in that of agricultural produce, has been maintained. The grapefruit industry, although still in its infancy, is now definitely established and expansion, mainly in the Stann Creek Valley, is gradually taking place. No new groves have come into bearing but the production of exportable fruit from the two original groves is on the increase. The advice of the Empire Marketing Board citrus expert, referred to in the 1927 report, has been of immense value and has brought about a great improvement in cultural and handling methods. The Marsh Seedless and Duncan are the only two varieties that have been thoroughly tested and for this reason new plantings are being confined to these varieties. In connection with this industry it is interesting to note that the Colony was awarded the Gold and Silver Medal for grapefruit exhibited at the 1928 Imperial Fruit Show, Manchester. Cacao was shipped again after a lapse of many years. This crop is to be specially attended to by the Agricultural Officer and it is hoped will form a new industry.—(*Colonial Report*, 1928, No. 1467.)

* * *

Swaziland.

The chief agricultural exports of Swaziland are slaughter cattle, tobacco, cotton, hides and more recently, wattle bark. Slaughter cattle exports have fluctuated considerably during the last four years. The exports of other agricultural products have increased steadily. In 1928 there were approximately 71,000 European owned and 291,000 native owned cattle in the territory. Although no serious stock disease outbreaks occurred, the work of the Veterinary Department has been largely directed against the spread of East Coast Fever. It appears that early measures and short interval dipping are still the most successful methods in use to deal with the disease.

Good crops of maize, Kaffir corn, beans and ground-nuts are grown. The cotton crop shows an improvement each year owing to the use of better seed, and the introduction by the Empire Cotton Growing Corporation of jassid resistant varieties.—(*Colonial Report*, Swaziland, 1928, No. 1459.)

REVIEWS.

The use of Potash on Tropical and Sub-Tropical Crops.

By E. Stägmeyr, Dip. Agr. *Agricultural Department, The Dominions Potash Supply, Ltd.*, London.

We have recently received a pamphlet on this subject from the Dominions Potash Supply Co., Ltd., Eastcheap, London, compiled by E. Stägmeyr, and recently issued as a sequel to a popular series of booklets written by Dr. A. Jacob and V. Coyle, but now out of print. The older series was reviewed in *Tropical Agriculture* for April, 1928, p. 94. The newer pamphlet follows similar lines, in that it starts with a general introduction to the principles of manuring, including the theory of balanced fertilizers, the method of mixing, and the mode of fertilizer application, followed by a discussion of the specific fertilizer requirements of tropical and sub-tropical crops, including rice, coffee, cocoa, sugar-cane, cotton, rubber, coconut, tobacco, citrus trees, banana and pineapple. Unfortunately, in a pamphlet of this sort, it is impossible to deal adequately with the various effects which fertilizer dressings exert on the soil, and through the soil, on the plant. It is tacitly assumed that one can accurately formulate a "balanced fertilizer" for any specific crop without regard to the type of soil on which the crop is grown. In the conclusion, however, it is stated that, since the "requirements of the soil in regard to plant-food cannot be determined by chemical analysis, the farmer who wishes to know what his soil needs must resort to . . . the carrying out of experiments . . ." Whilst this is sound in principle, it is obvious that the farmer cannot perform field experiments of a sufficiently high degree of dependability for the purpose suggested. The elaborate technique and lay-out of precise field trials is quite outside the scope of the average farmer or planter, and can only be applied confidently by specialist officers who have access to considerable areas of land, and to well-equipped chemical laboratories. It is quite useless to refer to plant-ash analysis, in the manner occasionally adopted by the author of this pamphlet, to support the contention that this or that particular crop-plant requires a particular quantitative mixture of fertiliser ingredients for its proper sustenance.

F. H.

* * *

Microbiology.

By B. F. Lutman, Professor of Plant Pathology, Vermont University. *McGraw-Hill Book Co.*, Inc., 1929. 495 pp. 211 figs. Price $4.

The study of modern microbiology is a difficult task, owing to the enormous mass of literature and data which has already been compiled on this very extensive subject. Lutman has made a good attempt to survey this information and to make it more accessible to the student.

The main portion of the book consists of a description of typical species (chiefly of bacteria) which of course permits the inclusion of more detail. The first and last few chapters are more general. There are numerous illustrations and diagrams, and a useful bibliography concludes each chapter.

It seems that Lutman would be successful in convincing the reader that he is "looking out over a sea of boiling controversy."

A. K. B.

* * *

Sisal, Production and Preparation.

By H. Hamel Smith. (*John Bale, Sons & Danielsson, Ltd.*)

The first portion of this volume consists of a collection of articles and reports on the cultivation and prospects of sisal in different parts of the world, some of them dating back as far as 1904. The second portion, dealing with manufacture, consists mainly of statements by makers of fibre, transport and cultivating machinery, on the good points of their own machines. It is useful at times to have such a book handy, but little has been done to correlate the information, nor does the arrangement of the sections conduce to easy reference. Mr. Hamel Smith is on less certain ground when he discusses Panama Disease, and it would perhaps have been better if all mention of it had been omitted.

R. C. W.

BOOKS RECEIVED.

We have to acknowledge the receipt of the following books:—

AGRICULTURE.

Textbook of Tropical Agriculture. A. Nicholls and J. H. Holland. *Macmillan & Co. Ltd.*, p. 640, 213 illustrations, 15*s*.

Recent Changes in Systems of Husbandry in England. J. Russell and Others. *E. Benn, Ltd.*, p. 56, 2*s*.

Coffee Growing, with special Reference to East Africa. J. H. McDonald. *East Africa*, p. 206, plates 12, 21*s*.

BOTANY.

The World's Grasses. J. W. Bews. *Longmans Green & Co. Ltd.*, p. 407, 21*s*.

GENERAL.

The Government Services in British Malaya. C. W. Harrison, *Malayan Information Agency*, p. 154.

TECHNOLOGY.

Tanning Materials of the British Empire. *The Imperial Institute*, p. 100, 2*s*.

A Handbook for Cane Sugar Manufacturers and their Chemists. G. L. Spencer. *J. Wiley (Chapman & Hall)*, 7th Edition, p. 560, plates 1, 30*s*.

ZOOLOGY.

Insects, Ticks, Mites and Venomous Animals. W. S. Patton and A. M. Evans. *Liverpool School of Tropical Medicine*, p. 786, 20*s*.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Fuel Consumption in Mauritius Sugar Factories.

With induced draft, such as is common practice, bagasse burning furnaces work with an excess of air which can be said to vary between the limits of 67 per cent. and 100 per cent., not taking into account such badly designed furnaces as require more than 100 per cent. excess air. It is assumed that feed-water heaters are only two-thirds of the capacity advocated by the makers, *i.e.*, 0.25 square feet instead of 0.352 square feet per kg. of feed water. On these assumptions, two graphs have been drawn for the average Mauritius plant, for 67 per cent. excess (good furnaces) and 100 per cent. air excess (ordinary furnaces). An analysis of these shows that, when working with a good furnace (67 per cent. excess air) and no boiler overload, 1 kg. of bagasse will produce 2.7 kgs. of steam per hour. However, in many factories, when required to produce white sugar, the boilers are found to be overloaded some 20 per cent., on a conservative average. In the circumstances, the boilers will produce 2.572 kgs. of steam per kg. of bagasse per hour. As the average weight of bagasse is about 245 kgs. per ton of cane, we find that with no overload the boilers will produce 660 kgs. of steam per ton cane hour, whereas with 20 per cent. overload the boilers will only produce 630 kgs. of steam per ton cane hour. The author has shown that for the manufacture of high grade white sugar, the steam consumption of a well equipped factory is in the neighbourhood of 750 kgs. of steam per ton cane hour; and for manufacturing raw sugar at 96° polarization, about 615 kgs. only per ton cane hour, being a saving of about 18 per cent. as compared with white sugar manufacture. Market conditions have, however, brought about the necessity of producing raw sugar at a polarization approaching as near as possible 99°, but the saving in steam for 99° polarization raw sugar is only 12 per cent. in comparison with high-grade white sugar manufacture. On this basis, the steam consumption would be reduced to about 660 kgs. per ton cane hour, and the overload of the steam producing plant under investigation will be reduced to about 100 per cent. instead of the 20 per cent. above mentioned. Consulting the graphs, one finds that in the particular circumstances now under consideration, the evaporative power of 1 kg. of bagasse per hour is 2.64 kgs., *i.e.*, 650 kgs. of steam per ton cane hour. Considering that most factories cannot be confined to the exclusive manufacture of raw sugar, but must also produce a certain proportion of white sugar, it follows that only such factories as crush canes containing more than 12½ per cent. fibre, or whose furnaces work with less than 67 per cent. excess of air, and whose boilers are not overloaded, can hope to dispense with extra fuel. Addition of air-preheaters besides economizers to the boiler plants would be a great improvement, and provide an abundant supply of steam for the manufacture of the so-called raw sugar. It would not, however, except in exceptional circumstances, meet the demands of a factory manufacturing high grade white sugar. Following this the author calculates that if economizers were discarded altogether, and air pre-heaters only were used, the position would be quite a different one. Thus with 85 per cent. efficiency, feed-water at 107°C., and 67 per cent. of air, 1 kg. of bagasse will evaporate 3.3 kgs. of water per hour and produce about 810 kgs. of steam per ton cane hour—and, even with 100 per cent. excess of air, the steam production is about 760 kgs. per ton cane hour or more than necessary for the manufacture of very high grade white sugar. Assuming for an average furnace a mean figure of 785 kgs. of steam per ton cane hour at normal rating, it is found that there will be surpluses of 8 kgs. and 40 kgs. of bagasse for the manufacture of high grade white sugar and 99° polarization raw sugar, respectively. For an average factory, working 20 hours daily and crushing 33 tons of cane per hour, the amount of surplus bagasse will be over five tons for high grade white sugar and about 26 tons for 99° polarization raw sugar per day. An exceedingly important consideration will be the necessity or not of closed hot-wells and their proper arrangement. It must be clearly understood that the advantages above indicated can only be obtained with plants that have been well proportioned and not merely laid down in a haphazard way.—(*The International Sugar Journal*, Vol. XXXII, No. 374.)

* * *

Cane Pulp as Food for Animals.

W. P. Naquin, manager of Honokaa Sugar Company, Hawaii, describes in the Hawaiian Planters Record, Vol. XXXIII, No. 4, the feed now being used for the work animals of that plantation. This feed is composed of dry, screened bagasse, molasses and soya bean oil meal in the proportion of 100-100-50. No other feed is used. It is used at the rate of three pounds for each hundredweight of live weight of animal per day. The results are reported to be entirely satisfactory, the animals showing a slight gain in weight since this mixture has been put into use. The cost of this new feed amounts to about 25 cents per animal per day, the average saving being close to $50 per animal per year.

* * *

Evaporator Incrustation.

In the incrustation of the first body of the evaporator of a beet factory a great amount of phosphoric acid was found to be present. Probably this was due to the presence of phosphoric acid compounds in the juice in the form of calcium glycerophosphate * this having escaped precipitation when liming was unsatisfactorily performed, but later settling out of solution on concentration.—(*I.S.J.*, Vol. XXXI No. 370.)

* As pointed out by Stanek, *Zeitsch. Zuckerind. Czecho-Slov.*, 46, 673.

THE LOW TEMPERATURE STATION.

BY

L. P. McGUIRE.

THE Low Temperature Station was erected for the study of the cold storage and transport of the banana; of late years the prevalence of Panama Disease, to which the Gros Michel banana, the chief variety of commerce, is susceptible, has necessitated a concerted attack on the problem from the genetical, pathological and physiological standpoints.

Our attack then involves plant breeding experiments with a view to the production of an immune or highly resistant hybrid of desirable bunch characteristics; secondly, the detailed study of the pathogenic organism, its mode of infection and spread, &c., with a view to curative or preventive measures; and thirdly, the selection of the most suitable of the existing varieties of proved immunity or high resistance, and the determination of the precise set of conditions suitable to its successful transport overseas and subsequent ripening to an attractive yellow colour.

From the point of view of cold storage, the banana is perhaps unique among the fruits which have claimed the serious attention of the refrigeration biologist. Most fruits are confined to a short season annually. Such fruits are picked comparatively mature, and when they are held under suitable conditions, senescence and decline may be delayed for varying periods, according to the variety in question, thus serving economic ends. The banana, however, fruits all the year round, and thus the question of storing the fruit so as to avoid the low prices of the "glut" does not arise. Furthermore, in sharp contrast with other fruits, the banana is harvested quite green; after a short period, during transport at temperatures in the neighbourhood of 53°F., it is ripened up in a few days at a higher temperature (about 70°F.) and placed on the market. In dealing, therefore, with a proposed substitute for the Gros Michel variety, our problem is the determination of the correct stage of maturity at harvesting, and the precise conditions during transport and subsequent ripening, which will ensure that the product for market is a neat and orderly bunch of attractive colour.

There seems little doubt that in the establishment of this Station, it was the intention of the Empire Marketing Board that Low Temperature Research here should, in due course, embrace storage trials of other fruits and vegetables which are either indigenous to, or may be cultivated in, the tropics.

The building was erected and equipped at a cost of approximately £5,800, which was met by a grant from the Empire Marketing Board. It consists essentially of an engine room, a physiological laboratory, an air lock (1,900 cubic feet), and four storage chambers; three of these have a capacity of 1,130 cubic feet and the fourth, which is considerably larger (2,340 cubic feet), serves the purpose of a ripening room.

The Refrigeration Plant consists of two J. and E. Hall's Vertical, No. 6 size, Ammonia Compressors, five inches bore by six inches stroke, direct-coupled to two 8¼ B.H.P. repulsion induction type Motors, the Compressors running at 220 r.p.m. and the Motors at 1,165 r.p.m. The whole electrical equipment is 60 cycle, 440 volts. The two oval coil Atmospheric Condensers, consisting of 265 feet of one and a half inches bore pipe, are cooled by a centrifugal circulating pump capable of delivering about 50 gallons of water per minute. The Brine Tank, in which are two evaporator coils of 275 feet each of one inch bore pipe, measures ten feet by four feet six inches by four feet six inches, and the cold brine is circulated through the air cooler coils by two centrifugal pumps, each capable of delivering 30 gallons of brine per minute. One pump is capable of dealing with the whole installation, the second being kept in reserve. The air-coolers, whereby the chambers are refrigerated, consist of 350 feet of one inch bore piping in the case of the larger ripening chamber, and 175 feet of similar piping for each of the smaller storage chambers. The fans deliver air at the rate of 2,500 cubic feet per minute in the case of the large chamber and 1,200 cubic feet for the smaller ones. They are of the centrifugal cased type, with full housings, and flanged suctions and discharges. They are fitted with dampers of the sliding type, and are direct-coupled to electric motors. The air lock is cooled with 250 feet of one and a half inches bore brine grids, which are carried from the ceiling and are fitted with Fibro cement drip trays. The floors are protected with cork slabs laid in two thicknesses, and the chamber walls and ceilings are covered with six inches of granulated cork, and are double boarded. Each chamber is fitted on both the delivery and the suction side with an electric distance thermometer, whereby the temperatures may be read in the engine room. This obviates the necessity for more frequent opening and shutting of the chamber doors, which interferes greatly with the maintenance of constant temperature and humidity.

With the possible exception of the research laboratories of the larger Fruit Companies interested in the export of the banana, this was probably the first established Low Temperature Research Station refrigerated throughout on the cold air blast system, which has been proved vastly superior in the transport and storage of fruits and vegetables in bulk.

The building was designed in collaboration with the experts of the Low Temperature Station, Cambridge, and of Messrs. J. and E. Hall, Dartford, and reflects great credit on the persons concerned, particularly the College Engineer, under whose personal supervision the building was erected and the refrigerating plant assembled.

THE LOW TEMPERATURE STATION.

Photograph by *Tucker Picture Co.*

FIG. 3.—*The Air Lock, showing storage chambers on the right and Ripening Room in the background.*

Photograph by *Tucker Picture Co.*

FIG. 4.—*The Ripening Room, during a storage trial.*

THE LOW TEMPERATURE STATION.

Photograph by *Tucker Picture Co.*

FIG. 5.—*The Air Trunks and Electric Thermostatic Controls.*

Photograph by *Tucker Picture Co.*

FIG. 6.—*The Engine Room.*

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Composition and nitrification studies on Crotalaria striata.

W. A. Leukel, R. M. Barnette, and J. B. Hester (*Soil Sci.*, 1929, 28, 347-371), record analyses of *Crotalaria* plants in various stages of growth, and trace the course of nitrate accumulation following incorpo ation wi h soil of the various parts of the plant in various growth stages. At all stages of growth the nitrogen content of the plant parts increases in the order : roots (least), stems, complete plant, leaves. The reverse order characterises the contents of cellulose and lignin. The carbohydrate content is fairly evenly distributed throughout the plant. In the complete plant there is an increase in the percentage of cellulose and lignin and decrease in the percentage of nitrogen as the plant approaches maturity. The rate of nitrification of the plant parts is greatest for leaves, followed, in descending order, by the complete plant, stems, and roots, there being a slight decrease in the case of leaves in the last stages of growth. When the complete plant is considered, nitrification declines with advancing age.—(*Journ. Soc. Chem. Indus.*, Vol. XLIX, No. 4, p. 75.)

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Sucrose in Manured Sugar-cane.

In his annual report, The Imperial Agricultural Chemist for India (W. H. Harrison) states that sugar-canes manured with potash yielded juices which contained the largest amount of sucrose and the lowest amount of glucose. Ammonium sulphate gave low sucrose and high glucose contents of juice. Super-phosphate gave intermediate results. The unmanured canes of the control plots gave results inferior to those with potash but superior to those with other manurial substances.—(*Agric. Res. Inst. Pusa*, Rept. 1927-1928.)

* * *

Bamboo for Papermaking.

In an article that appeared in the *Proceedings of the Papermakers' Association* (Vol. VIII, 1927, p. 89), Mr. W. Raitt maintains that bamboo stems can provide an almost inexhaustible source of paper pulp.

The early difficulties of bleaching have now been overcome, and the waste due to the resistant nature of the hard nodes has been eliminated by the use of suitable crushing machinery. A satisfactory factory procedure consists in fractional digestion of the woody material, employing in conjunction a sulphate-soda process requiring 16 per cent. soda applied at 24 lb. pressure per square inch for 5 hours. By this means, 100 parts of bamboo stems yield 45 parts of pulp, requiring only 8 parts of bleaching powder for satisfactory decolorization. It is estimated that unbleached bamboo pulp could be delivered at British ports for about $56 per ton.—(*Chem. Abstr.*, Vol. XXIII, No. 12, 1929.)

Patents on Pest Control.

The United States Department of Agriculture has issued a "Review of United States Patents Relating to Pest Control." This has been compiled by R. C. Roark of the Insecticide Division of the Bureau of Chemistry and Soils, and presents abstracts of patents relating to pest control. The review gives the patent number with date, subject, patentees, and assignees, and a brief abstract of the patent, complete copy of which can, of course, be obtained for 10 cents, in cash or coupon, from the Patent Office. The review is indexed by assignees, patentees, and subjects, and may be procured upon application to the office named.—(*Indus. Eng. Chem., News Edit.*, Vol. VII, No. 14, p. 9.)

* * *

Alcohol as Fuel.

A summary of the results of some tests made with internal combustion engines using mixed fuels consisting of petrol, alcohol and benzene may be of interest to those concerned with the manufacture of alcohol. The conclusions reached were :—

1. Petrol-alcohol-benzene mixtures containing varying quantities of petrol and alcohol are suitable for use in petrol engines without any alteration beyond widening the carburettor jet.
2. A petrol-alcohol mixture cannot be used satisfactorily.
3. Detonation is unlikely.
4. The volumetric fuel consumption increases with the volume of alcohol in the fuel.
5. The thermal efficiency obtainable is similar to that of petrol.
6. The difference between mixture strengths giving maximum economy and the theoretical mixture strengths is greater with these fuels than with petrol.
7. The mixture strength required to obtain maximum economy is nearer the limiting strength for smooth running for these fuels than with petrol.

From these results, the petrol-alcohol-benzene mixtures do not appear to be as satisfactory as petrol, when used in the present form of the internal combustion engine.—(*Chem. and Ind. Journ.* Vol. XLVIII, No. 52.)

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Tartaric Acid in the Argentine.

After a year's study of the situation, the Imperial Chemical Industries plans the construction of a plant for the production of tartaric acid in Buenos Aires, Argentina. Raw material is to be obtained from the wine industry in Mendoza and San Juan. A local company, Sociedad Anonima Rivadavia, is to be organized to control the undertaking. It is understood that the I.C.I is studying the possibility of locating other factories in Argentina, believing that the country offers splendid opportunity for chemical development.—(*Industrial and Engineering Chemistry, News Edition*, Vol. VII, No. 16.)

AGRICULTURAL EXCURSIONS.

An excursion was made to Palmiste, Sir Norman Lamont's estate on Wednesday, 26th February. This estate is a large one and consists of about 250 acres planted in cacao with a smaller area of coffee, a considerable area of coconuts and other lands leased out to cane farmers. The decision to change over from sugar to cacao was made about 20 years ago and in spite of the generally accepted local opinion that the area was too dry for cacao, it has proved a striking success. The opportunity of seeing the process of actually establishing a cacao plantation and of observing the cultural methods employed in the fields of different ages were greatly appreciated, and all members of the party took the chance afforded for discussing various points of field practice with Sir Norman Lamont and his Manager, Mr. Augustus. The healthy appearance of the trees and the high yields that are secured are an excellent illustration of the success of sound agricultural methods combined with the use of good planting material, since all the plants were raised from seed obtained from specially selected high yielding trees at River Estate, the Cacao Experimental Station of the Trinidad Department of Agriculture. The coffee fields contained a representative series of varieties and the possibility of studying them in close conjunction to each other was greatly appreciated. The coconut area afforded many interesting problems and the general opinion was expressed that the greatest care was being taken to obtain the best results on land that as a rule did not strike one as being really suited to this crop. Sanitary precautions against the spread of "red ring" and "bud rot" were demonstrated and the burning of the trees by spraying with oil was an excellent illustration of the care that is being taken to endeavour to maintain the health of the plantations. The College party enjoyed the hospitality of Sir Norman Lamont at a sumptuous luncheon and were much interested in his remarks about the coconut industry in Trinidad and its possible extension.

On Wednesday, 5th March, a visit was paid to Caroni Estates where the party were met by Mr. L. Grant, the Manager. An excellent demonstration of dry weather ploughing and harrowing by Fowler's tackle was given and its effect on controlling pests such as Froghopper and of improving the soil conditions for the succeeding cane crop was discussed. The need for farm yard and other organic manures on this class of heavy clay was insisted on and the method of making manure in open pens was demonstrated. The best manure is apparently made under these conditions when alternate layers of long and chaffed cane tops and trash are incorporated in the pen. The position of such thin and hardy varieties as Uba and Coimbatore in the economics of the cane estate were discussed and harvesting and carting costs were gone into. The thanks of the College are due to Mr. Grant and the management of the Caroni Estates for the excellent arrangements made for the excursion.

G. E.

COLLEGE NEWS.

Mr. George E. Vincent, the retiring President of the Rockfeller Foundation and Mrs. Vincent visited the College on 26th February.

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We wish to express our sympathy to Mr. W. Scott, Professor of Technology, who is suffering from serious injuries sustained through a motor accident.

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Mr. F. W. Urich, Assistant Professor of Zoology and Entomology, will represent the College at the Third Imperial Entomological Conference which is to be held in London in June.

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Dr. A. W. Hill has been re-appointed by the Secretary of State for the Colonies to be one of his representatives on the Governing Body of the College for a further period of four years as from February, 1930.

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Mr. W. A. Tansley, formerly Accountant to Hopps and Bankart, Chartered Accountants, England, and to Messrs. Hunter, Smith and Earle, Chartered Accountants, Trinidad, has been appointed Accountant at the College as from 1st April, 1930.

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Mr. E. E. Cheesman, Professor of Botany and Genetics, will represent the College at the Conference of Empire Horticulturists, at the ninth International Horticultural Congress, at the Imperial Botanical Conference and at the fifth International Botanical Congress.

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Mr. E. E. Cheesman, Professor of Botany and Genetics, and Mr. H. A. Ballou, Professor of Zoology and Entomology and Commissioner of Agriculture for the West Indies, returned from St. Vincent by s.s. *Lady Nelson* on 20th February. Mr. G. A. Jones, Assistant Commissioner of Agriculture for the West Indies returned from the same Colony by s.s. *Lady Hawkins* on 6th March.

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The thanks of the College are due to Messrs. Elders and Fyffes, Ltd. who have contributed £500 to the funds of the College and who have also been very generous in the matter of providing free passages on several occasions to Officers of the College proceeding on tours in connection with Banana Research.

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Mr. J. Hammond, of the Animal Nutrition Institute, Cambridge, arrived from Jamaica on 14th February. He has been appointed by the Empire Marketing Board to investigate the inheritance of milk and other characters in crosses between the Zebu and European breeds. Since his arrival he has pursued his investigations into this problem, making his headquarters at the College. At a meeting of the Trinidad Science Club which was held on 20th February, he gave an interesting illustrated address on "Recent researches in animal production." Mr. Hammond sailed for England by s.s. *Bayano* on 14th March.

Amongst recent visitors to the College were Mr. J. C. Hutson, Entomologist, Department of Agriculture, Ceylon; R. G. Terry, Director, Messrs. Terry and Sons Chocolate Works, York; Dr. Previté, Director, Trinidad Asphalt Company; J. Stuart Rayside, Director, Canadian National Steamship Company; Mr. McCutcheon, Canadian Naval Service; Hon. F. S. G. Calthorpe and several members of the M.C.C.; and Dr. Hans Freihern von Berlepsch of Burg Seebach, Thuringia, the well known German ornithologist and author of *Der Gerammte Vogelschutz*, a classical work which is now in its twelfth edition, and has been translated into numerous European languages.

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Dr. and Mrs. J. G. Myers returned to Trinidad by s.s. *Camito* on 14th February; Mr. A. Pickles returned by the same opportunity. Dr. and Mrs. Myers left early in July last year for the Greater Antilles. At first a base was made at the Harvard Tropical Laboratory at Soledad, Cuba, and expeditions were made from there not only to various parts of Cuba but also to Haiti and Santo Domingo. The journey from Havana to Port-au-Prince, Haiti, was made by aeroplane with a view to investigating the possibilities of this means of transport for beneficial insects, which it is proposed to introduce into the British colonies. The base was later moved to Jamaica, many parts of which were visited during the course of five weeks field work.

OFFICERS GOING ON LEAVE.

The following members of the College Staff are expected to proceed on leave during the coming Long Vacation: Mr. E. E. Cheesman, Professor of Botany and Genetics, Mr. G. G. Gianetti, Editor-Librarian, Mr. A. G. Howell, Registrar, Mr. G. A. Jones, Assistant Commissioner of Agriculture, Mr. F. W. Urich, Assistant Professor of Zoology and Entomology, Mr. P. E. Turner, Lecturer in Chemistry and Soil Science, and Dr. C. W. Wardlaw, Banana Pathologist.

ERRATA.

Sugar-Cane Moth Borer.

Vol. VI No. 11, page 311, second column, line 6. For "there would thus be 150 slips or 7,500 parasites per acre" *read* "there would thus be 15 slips or 750 parasites per acre." Also, same page, first column, line 51. For (Vol. VI, No. 8, July, 1929), *read* (Vol. VI, No. 8, August, 1929).

THE EDITOR is prepared to consider signed articles for publication in *Tropical Agriculture*. Such articles should normally vary between 1,000 to 6,000 words and may be illustrated if desired. Rates can be obtained on application to the Editor.

COLONIAL APPOINTMENTS.

The following appointments and transfers have been made during the month of January, 1930, by the Secretary of State for the Colonies:—

Mr. D. B. Palmer, Produce Inspector, Nigeria.

Mr. L. R. Swindells, Produce Inspector, Nigeria.

Mr. D. C. Edwards (Agricultural Instructor, Sierra Leone), Agricultural Officer, Kenya.

Mr. C. B. Taylor (Superintendent, Agricultural Department, Nigeria), Botanist, Nigeria.

THE BANANA BORER.

(*Cosmopolites sordidus.*)

IT has been the custom in the West Indies to soak banana suckers for 48 hours before planting, as a precaution against banana borer. Mr. H. W. Simmonds, Government Entomologist of Fiji, informs us that he has carried out a series of experiments with the object of obtaining clean suckers from infected plants, and finds that it is possible to do this by immersing them to a depth about four inches above the point where the aerial stem joins the corm, leaving the remainder of the plant exposed to the air and allowing it to remain in the water for a period of 21 days. Care must be taken not to immerse the sucker totally or the plant will die.

Experiments showed that mature larvae are able to pupate and survive a period of 14 days immersion, which period was sufficient to kill the suckers themselves, when these were totally immersed, but by allowing the top to remain free the sucker can survive a period of 21 days, which is sufficient to destroy all the borers in the plants.

F.W.U.

EXAMINATION RESULTS.

The following students have been awarded the Associateship of the Imperial College of Tropical Agriculture:

Mr. O. V. S. Heath, A.R.C.S.

Mr. E. W. Gaddum, B.SC. Agric. (Lond.).

Mr. R. D. Linton, B. Agric. (Belfast).

Mr. R. Turner, B.SC. Agric. (Edin.).

Mr. B. J. Hartley, N.D.A.

ACKNOWLEDGMENT.

We acknowledge, with thanks, the gift of "The British Tortrices" by S. J. Wilkinson, and the First Report of the Wellcome Research Laboratories, kindly presented by Lady Gilbert Carter.

PUBLICATION FOR SALE.

COPIES of *Insect Pests of the Lesser Antilles*, by H. A. Ballou, price *2s. 6d.* can be purchased on application to the Editor, *Tropical Agriculture*.

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—Prices on the Home Market have ranged as follows (*c.i.f.* per cwt.):

	Foreign.	*Preferential.*
	s. d.	*s. d.*
30th January	7 6	11 0
7th February	7 9	11 6
20th February	7 6	11 3
25th February	8 4½	11 3
28th February	7 1½	11 0
2nd March	7 0	11 0
7th March	7 3	11 0
14th March	7 4½	11 1½

Reports received from *C. Czarnikow Ltd.*, indicate that dull and uninteresting conditions prevailed in Sugar markets up to the third week in February. The question of restricting the present Cuban crop appears to have been abandoned for the time being as planters on 17th February voted unanimously against it. With the present heavy statistical position there is very little of an encouraging nature to report for the immediate future. At home, political uncertainties and ample stocks militate against free movement of sugar. The removal of budget fears should lead, however, to more normal activity. In America, heavy stocks, fears of pressure of duty free sugars and the difficult Cuban position are discouraging features; the pressure of duty free sugars must, however, necessarily lessen as the year progresses and thus bring the Cuban Single Selling Agency into greater prominence as a market factor.

* * *

COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association :—

	American Mid.	*Egyptian F. G. F. Sakel.*	*Sea Island.*		
			Good.	*Extra fine.*	*Prices paid this Week.*
17th Jan.	9·49	14·45	24·50	38·00	
24th Jan.	9·40	14·50	24·50	38·00	32·00
31st Jan.	8·85	14·25	24·50	38·00	
7th Feb.	8·60	13·75	24·50	38·00	
14th Feb.	8·69	13·70	24·50	38·00	
21st Feb.	8·47	13·50	24·50	38·00	27·00-32·00
14th March .... (local)	9·15	·	—	—	—

Almost continuous declines have taken place in the prices of American and Egyptian since the end of January. The general market is said to have suffered from Continental and Bombay liquidations and straddle selling from the same interests. A great deal of attention has been paid to the activities of the Federal Farm Board who have taken on the task of encouraging the reduction of the acreage of both wheat and cotton. Sea Island has been in limited demand without quotable change.

* * *

COCOA.—For some unaccountable reason, activities on the New York Cocoa Exchange have been centred on "bearing" prices, with the result that the market has been lower and very weak. Considering that the bulk of the available Accra cocoa is supposed to be in the hands of the "Pool" this state of affairs cannot continue, unless they have decided to sell at a loss, which we doubt.—(*By courtesy of the Trinidad Cocoa Planters' Association.*)

* * *

TEA AND COFFEE.—Latest averages (per lb.) for tea are Ceylon 17.00*d.*, Indian 13.36*d.*, Java 8.97*d.* Coffee in Brazil is now valued at 67*s.* 6*d.* a cwt. as against 92*s.* 6*d.* a year ago. Fine coffee is an entirely separate market and the outlook seems good.

* * *

RUBBER.—Quotations for Plantation Sheet have ranged as follows: 22nd January, $7\frac{5}{16}d.$; 29th January, $7\frac{7}{16}d.$; 7th February, $7\frac{13}{16}d.$; 14th February, $8\frac{1}{16}d.$; 21st February, $8\frac{5}{16}d.$; 28th February, $7\frac{13}{16}d.$; 7th March, $7\frac{11}{16}d.$ According to *Messrs. Symington and Sinclair* the rubber market has been firmer and more active. The sharp rise in prices in the third week of February was due to the fact that a meeting of Dutch rubber producers held in Amsterdam was said to have agreed in principle to a total cessation of tapping for the month of May provided 70 per cent. of the producers were willing to agree. This news was unconfirmed and incomplete on 19th February.

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BANANAS.—Jamaicas are in fair demand and unchanged at £22 10*s.* per ton delivered, or £22 delivered nearest railway station, to wholesalers, and 10½ to 1*s.* per dozen (carriage extra) to retailers. In view of the season of the year, Brazilians are in good demand at £20 per ton delivered nearest railway station.—(*West India Committee Circular 20th February*, 1930.)

* * *

LIME PRODUCTS.—*Lime Oil.* A fair business in Handpressed has been done at 50*s. ex* wharf, London. No business in Distilled is yet reported and buyers are difficult to interest. *Lime Juice.* Concentrated is unchanged. The last price was £18. Raw is neglected.—(*West India Committee Circular 20th February*, 1930.)